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MANAGEMENT OF A SMALL FISH POND IN TEXAS

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There is a widespread interest in the cultivation of fishes in farm ponds and it seems desirable that actual records of management be published. This paper presents the results of a census, after poisoning, of the population in a half-acre farm pond, together with records of planting, growth, and some recaptures but not a complete census of fish for one year. The pond is located in Brazos County near the campus of the Agricultural and Mechanical College of Texas. The owner, Mr. Charles J. Gorzycki, allowed students in the Department of Fish and Game of the College to work with this pond, which he had stocked nine years previously with fish from nearby streams. The water was continuously muddy with colloidal clay. A 4-inch white disc could seldom be seen at a depth of six inches, and usually at four inches or less; the bottom generally was visible through only one inch of water. The pH of the water was 7.8.

Various plants introduced some years previously by the owner had become well established by 1939. Willow (*Salix nigra*) grew on the dam, and sedges (*Carex*), arrowhead (*Sagittaria*), and rush (*Juncus*) were abundant around the edges. Water primrose (*Jussiaea diffusa*) covered an estimated 200 to 400 square feet in water from one to three feet deep and in May 1940, four man-hours were required to uproot or break off and throw ashore the visible parts. Some of the roots remained, but no appreciable amounts of water primrose had reached the surface by August 1941. Poison bean (*Daubentonia drummondii*) threatened to become a nuisance in water up to two feet deep but was removed manually in 1939, and by August 1941 had not returned.

In April 1940 the pond was surveyed and mapped, then poisoned to count the fish. The area was 0.54 acres, the greatest depth 6 feet, volume 60,000 cubic feet, and weight of water 3,800,000 pounds. Four pounds of cube root (rotenone content, 4 to 5%) were used to produce a concentration of about 0.5 p.p.m. as recommended by J. W. Leonard (Notes on the use of derris as a fish poison, Amer. Fish. Soc. Trans., 68: 269–280, 1939). Distributing the poison required 5 minutes. The first fish, a bluegill, died in about 20 minutes. Within 40 minutes many fish were dead, and within two hours all that were to die from the poison had succumbed, although some carcasses did not rise to the surface until the following morning when the remaining dead fish were removed. More than 107 pounds of fish

were killed (Table 1); 57 pounds, about half of the total, consisted of suckers. There were two smallmouth buffalo heavy with eggs. The carpsuckers included large specimens (2 to 5 pounds) of both sexes and small ones as well, indicating that spawning of this species had been successful. White crappies were numerous but small, only three being of legal size. The bluegills were numerous but stunted, the largest being 6.5 inches long. The lengths of fish given in this paper are total, measured to the tips of the longest caudal rays. Of the largemouth bass, four weighed over one pound each; the largest weighed 2 pounds. In addition 2 bass each of 3.5 pounds had been removed by angling shortly before the poisoning. Thus the total weight of bass supported by the pond was about 14 pounds.

TABLE 1.—FISHES COLLECTED IN A HALF-ACRE TEXAS POND, MARCH 29, 1940, TO APRIL 13, 1940.

Species	*Number*	*Total length, inches*	*Total weight, pounds*
Smallmouth buffalo (*Ictiobus bubalus*)	2	26–27	38
White crappie (*Pomoxis annularis*)	435	3.5–7.1	25
Carpsucker (*Carpiodes carpio*)	11	3.5–19	19
Bluegill (*Lepomis macrochirus*)	541	1.0–6.5	12
Largemouth bass (*Huro salmoides*)	19	3.5–13.5	7.1
Green sunfish (*Lepomis cyanellus*)	75	2.0–7.5	3.7
Warmouth bass (*Chaenobryttus gulosus*)	80	1.6–7.6	3.0
Hybrid: warmouth bass×green sunfish	1	4.5	0.05
Mosquitofish (*Gambusia affinis*)	6	1.0–1.7	tr.
Shiner (*Notropis*)	1	2.3	tr.
Totals	1171		107

Mosquitofish were noticeably immune to the poison; there were hundreds present, but only 6 died. Many were seen alive and apparently unaffected, although the poison reached the shallowest parts of the pond. After the poisoning and before planting other fish, the mosquitofish thrived, growing numerous and large. One 2.25 inch female contained 188 young nearly ready to be born. In another pond similarly poisoned almost all mosquitofish survived, and the largest female contained 354 young. These fish normally contain far fewer young. The only cyprinid was a bait minnow, undoubtedly introduced from the Brazos River, when there had been some bait fishing shortly before the poisoning. No living fishes except mosquitofish were obtained when the pond was seined one and two months later, on April 17 and May 17, respectively.

Plantings were made on May 17, 1940, of 49 bluegill fingerlings 2 to 3 inches in length, and on June 14 of 17 largemouth bass fingerlings 1.25 to 2 inches in length. On January 13, 1941, 16 mosquitofish and 595 bluegills were removed. The largest bluegill was a 5.5 inch male; the next largest, 2.3 inches, was undoubtedly the offspring of some of the original 49 introduced in May. The remainder were from 0.5 to 1.6 inches long. The presence of so many small bluegills suggested that spawning had started in the autumn and had continued throughout the unusually mild winter, but that overpopulation had retarded their growth. Bluegills soon became so numerous that removal

of 800 fry and fingerling from 0.75 to 1.5 inches long produced no apparent diminution in the population. The first largemouth bass was recaptured on March 20, 1941; it was 11.8 inches long and weighed 1.1 pounds.

Consent was not obtained to poison the pond for a final census, hence it was seined with a net reaching across the water on April 3, 1941. The fish were marked by removing a scale sample from each, and returned to the water; the pond was then reseined to check on the efficiency of the first seining. In this way 10 bass averaging 1.07 pounds were obtained and at least one more was thought to be present. Including the specimen of March 20, this made a total of at least 12 bass aggregating 13 pounds known to have been produced by the pond in one year. The fish were in good condition, the fins and heads small and the bodies deep and fat.

Tentative information on the readability of scales was obtained from these fish of known age. Scale samples from largemouth bass on April 3 showed the beginning of annulus formation and one or two circuli already formed beyond the annulus. On May 6 two scales showed the first annulus situated back from the periphery of the scale at a distance equal to about 6 circuli. This fish was returned to the water. Among the 4 bluegills taken April 3, annuli were lacking except on one with scales showing a well-defined annulus about half way from focus to periphery.

Spawning of the bass had not occured by April 4, when observations ended, although ripe appearing eggs were seen issuing from two bass the previous day.

The food of the bass and bluegills was determined only when possible to do so without disturbing the balance of the pond by removing large samples. The bass taken on March 20 contained 0.5 cc. of stomach materials—fragments of crayfish (*Cambarus*) and two nymphs of mayfly (*Hexagenia*) 15 mm. long. While the bass were being weighed on April 3, fragments of crayfish issued from the anus of one. Crayfish were abundant in the seine hauls and must have been an important food item for bass. The 5.5-inch bluegill on January 13 had a full stomach containing 11 crayfish less than one inch long and one small dipteran larva.

Twenty crayfish less than 3 inches were examined and found to be eating bluegill fry; 40 per cent contained bluegill fry which they had caught by their own efforts and not as a result of the netting operation. Because of their great numbers, these small crayfish retarded the overpopulation of the pond by bluegills.

SUMMARY

1. Management of a half acre pond in Brazos County, Texas, was conducted by help of students at Texas A. and M. College.

2. Undesirable concentrations of poison bean (*Daubentonia drummondii*) and water primrose (*Jussiaea diffusa*) were removed by hand and did not return to an objectionable degree within 16 months.

3. Poisoning with 0.5 p.p.m. of cube root (rotenone content, 4 to 5%) killed all fish except mosquitofish (*Gambusia affinis*). The population, of nine years' standing, yielded 107 pounds, of which the most important were smallmouth buffalo (*Ictiobus bubalus*), 38 pounds;

white crappie (*Pomoxis annularis*), 25; carpsucker (*Carpiodes carpio*), 19; bluegill (*Lepomis macrochirus*), 12; largemouth bass (*Huro salmoides*) 7; and four others in smaller poundages. The buffalo and some carpsuckers and largemouth bass were large, but the crappie, bluegill, and others were small.

4. The mosquitofish did not succumb to the poison and thrived after removal of other fish; females grew large and contained excessive numbers of young.

5. After poisoning, the pond was stocked with fingerlings, 49 of bluegill and 17 of largemouth bass. In one year bass grew to weigh one pound but did not spawn. The bluegills spawned in less than 8 months and continued to spawn for the remainder of the winter and spring.

6. Of the abundant small crayfish in the pond, 40 per cent of a sample contained bluegill fry; they therefore effected a desirable reduction in the bluegill population.

IMPROVING CONDITIONS FOR MIGRATORY WATERFOWL ON TVA IMPOUNDMENTS[1]

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Wherever and whenever waters are impounded for multipurpose use, fluctuations in level are unavoidable. Any secondary program associated with such impoundments must consider the effect of these variations in level. In a fish and wildlife program on multiple-use reservoirs, the "time of occurrence" of fluctuations is perhaps fully as significant as the extent of the drawdowns.

This paper explains how water-level fluctuations affect the abundance of ducks wintering in the Tennessee Valley, and suggests certain positive measures that may, to a significant extent, counteract the influence of wide fluctuations and seasonal recessions in water level. Since this region is not used extensively by ducks for nesting or summer feeding, we are concerned primarily with conditions that prevail during the winter.

The Tennessee River Valley is not on a major flyway, except for the lower several hundred miles which may be considered as an outer fringe of the Mississippi Flyway. Nevertheless, reasonably large numbers of ducks traverse the Valley during spring and autumn migrations, and many winter on the TVA impoundments. The number of birds now wintering on these impoundments, however, is far below the expectations of hunters and conservationists.

The writer believes that the number wintering in the impoundments is limited primarily by the annual winter drawdown for flood control. To some extent, the water is fluctuated for power and for malaria control but the variations in level for these purposes are of smaller magnitude than for flood con-

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trol. Too, the fluctuations for power are less pronounced in winter than summer, and those for malaria control are restricted primarily to the mosquito breeding season.

The effect of drawdown on the abundance of ducks is indirect. It concerns the production and availability of food plants. Even at the height of the drawdown, the TVA impoundments provide several hundred thousand acres of open water, but available food is scarce.

DUCK FOOD

The food upon which ducks depend and the absence or presence of which determines whether they will pass as migrants or remain as a resident winter population may be divided on the basis of habitats: (1) aquatics, submerged and emergent; (2) mudflat species; and (3) terrestrials, wild and cultivated. The growth or availability of aquatic and mudflat species is seriously affected by water-level fluctuations.

SUBMERGED AQUATICS

The growth of these plants depends on the ability of sunlight to penetrate the water. Turbidity therefore determines the depth to which submerged aquatics can grow. In most or all TVA impoundments, the depth of the zone of annual water-level fluctuation exceeds the penetration of sunlight adequate for growth of aquatics. In clear storage reservoirs the transparency may, at times, exceed 30 feet, but the annual drawdown for flood control may be as much as 60 feet in some and more than 100 feet in others. Drawdown in main-stream reservoirs generally is less than 10 feet, but the transparency there is usually low; in such impoundments the turbidity may be attributed to a combination of factors: (1) many rough fishes in the extensive backwaters (2) erosion of the watershed; and (3) rapid exchange of water volume, affording little time for silt to settle. In the main-stream reservoirs there are few areas, except as noted below, where the transparency would be as much as six or seven feet for any length of time; in many shallow backwaters the light penetration does not exceed one foot or even six inches. The lower sections of such reservoirs are less turbid but this is of no practical value in the production of duck foods because those sections generally have steep shorelines and no extensive areas of shoal water.

We may take for granted, therefore, that submerged aquatics will be sparse or absent in TVA impoundments because the depth of annual drawdown is greater than that of light penetration. Even if submerged aquatics were encouraged by constant water levels in summer, the plants would be "high and dry" in winter when levels are low for flood control.

EMERGENT AQUATICS

What has been said about submerged plants applies with minor variations and exceptions to the emergent types. After once above the water surface, the latter are less dependent on the transparency of the water. They also will stand dewatering much better than submerged aquatics. Emergent plants, however, may be destroyed when submerged by highly turbid floods.

MUDFLAT PLANTS

In many sections of the TVA impoundments some valuable duck food

plants grow abundantly along the margins of the reservoirs, and invade the zone of water-level fluctuations. Provided the recession of the water is controlled, especially with respect to time, considerable quantities of duck food may be produced annually within the drawdown zone. The schedules of water-level management and shoreline conditioning for malaria control now in effect favor the development of mudflat food species as against useless woody plants. Much of the potential value of these plants as duck food, however, is lost because, when the birds arrive, the water margin is so far from the vegetated zone that the ducks will not cross the bare mudflats intervening to reach the food. Were it practical to raise the water during November and December and flood some of this marginal vegetation or reduce the distance between the water and the vegetation, the ducks would use these plants extensively. This is a good illustration of the distinction between abundance and availability. These mudflat plants are highly important; they occur in great abundance, are extensively utilized by ducks if available, and their perpetuation along the reservoir margin above the water margin is assured by routine shoreline maintenance for malaria control.

TERRESTRIAL SPECIES

Several kinds of ducks will leave the water occasionally and wander inland to feed on terrestrial plants. They frequently utilize acorns and will invade cornfields to feed on the mature grain, as also cereal crops that remain in the field during the duck season. After the birds become acquainted with the location of such cultivated crops, they will leave the water and fly directly to the feeding area at the appropriate time of day.

CORRECTIVE MEASURES

Available duck food is scarce in the fluctuating TVA reservoirs in winter because of the drawdown for flood control. The latter is a major objective in the TVA program and winter drawdown is inevitable; hence the impoundments will be no winter paradise for ducks. Several corrective measures can be beneficial to the waterfowl, by making food available.

PROVIDING TERRESTRIAL PLANTS

In some sections of the country ducks that leave the water to invade adjacent fields are responsible for serious crop damage. This may never be serious in the Tennessee Valley because few mature crops remain in the fields by the time ducks arrive. The birds, however, will feed in green fields of autumn-planted cereals during the winter. Such terrestrial feeding suggests something that can be done for ducks to offset, to some extent, the adverse effect of water-level fluctuation. If agricultural crop lands are devoted to production of duck food, such lands must be properly located with respect to the water, and there is a limit to which crop lands can be used for this purpose, especially at the present time.

The U.S. Fish and Wildlife Service has indicated that leaving part of a domestic crop in the field to attract ducks does not constitute baiting so long as the crop is not manipulated in any way; hence any landowner adjacent to the reservoir might do something to encourage the ducks to remain. Organ-

ized sportsmen also may see a possibility to aid their favorite recreation.

DEWATERING

Several backwater areas, chiefly in main-stream reservoirs, might be dewatered during the summer for more economical malaria control and also to benefit waterfowl management. Other areas, where the need in respect to malaria control is not indicated, might be dewatered during the summer for the benefit of wildlife alone. Useful plant species will grow and fruit in areas dewatered during the main portion of the mosquito breeding season, and these plants are utilized by the ducks during the autumn and winter, provided the areas are then flooded entirely or partly. It is important to control the water level behind dikes that separate these management areas from the main reservoir. Such dewatering projects can be used with maximum effect only when they can be drained or refilled independently or, in other words, when required. In many such potential areas this might require pumping, either into or out of the backwaters. Hence dewatering for the benefit of waterfowl is limited, at least until it can be determined what expenditures are justified for these migratory birds.

Two experimental dewatering projects on Wheeler Reservoir initiated jointly by TVA and the U. S. Fish and Wildlife Service were far advanced before the war and doubtless will be completed as soon as conditions permit. Plans for a third project on Wheeler Reservoir, partly within the refuge, were completed in 1942, but not executed.

A 68-acre pond adjacent to Chickamauga Reservoir (Tennessee) has been made available to the TVA Biological Readjustment Division for the benefit of migratory waterfowl. The pond can be filled and drained by gravity independently of the reservoir, and ducks already have shown a preference for the area.

In Blackwell Swamp, one of the two partly completed dewatering areas, water levels were manipulated somewhat in the winter of 1943–44. The ducks concentrated in Blackwell Swamp where there was less food than in some other localities. The food was made available to the birds by flooding some vegetation which had grown on land while the latter was partially dewatered. This again suggests the importance of availability as distinguished from abundance.

Use of dewatering projects offers an opportunity to do something constructive and practical for migratory waterfowl and should be considered as part of the post-war wildlife program.

CONSTANT-LEVEL POOLS

Pools of relatively constant level, if under complete control and strategically located, are another means to improve waterfowl habitat. These have the additional advantage of providing a stable habitat for muskrats. To be really effective, the water supply should be under control, at least as to volume and transparency. Large amounts of turbid flood waters should be kept out. The exclusion of rough fish species is of primary importance; they may destroy existing vegetation and if present in large numbers may make the water so turbid that submerged aquatics cannot thrive. The control of useless and ob-

noxious plant species is another problem that cannot be ignored, especially in southern waters where some such pests are common—lotus is an example.

Constant-level pools with heavy growths of aquatic plants, especially emergent species, afford excellent breeding places for malaria mosquitoes. For this reason, such ponds should be at least one mile from human dwellings occupied at night; otherwise the water levels should be managed on a schedule favorable for malaria control. The 68-acre pond mentioned above could also be used as a constant-level pool, but will be more useful as a dewatering project, because of both the malaria control aspect and the presence of rough fish in the inlet.

SUMMARY

Water-level fluctuation in a managed area (e.g., TVA), especially the drawdown for flood control, imposes serious limitation upon a program for management of migratory waterfowl, notably in winter. Limited developments for ducks are possible through the use of some agricultural crops as duck food, summertime dewatering, and maintenance of constant-level pools.

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ALTERNATIVE METHODS IN UPLAND GAMEBIRD FOOD ANALYSIS[1]

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This paper compares two methods used currently in making final summaries of data obtained from analysis of food in crops and gizzards of upland gamebirds. Since the alternative methods are based on different analytic procedures, discussion of these pro-

[1] While associated with the Maine Cooperative Wildlife Research Unit, Orono, Maine, C. P. Brown prepared a manuscript on tabulation methods in gamebird food studies which closely paralleled conclusions in a manuscript prepared by A. C. Martin and R. H. Gensch. By mutual consent, the present paper is offered as a joint contribution.

cedures must be included in the comparison.

THE METHODS

In analyzing crops or gizzards to ascertain bulk proportions of the items contained, it is general practice to record for each kind of food item a figure indicating the percentage of that item in the total crop or gizzard content. Formerly this percentage was obtained by visual estimate of relative proportions; the actual volumes of food items were rarely measured, and in most cases were not recorded. A decade ago, in upland gamebird food analyses, percentages were the only expression of relative volume used.

There then was no problem in tabulating data since the only method was of averaging percentages. In recent years, however, many workers have based their studies primarily on crops instead of gizzards and have used actual volumetric measurements extensively in preference to visual estimates. These changes in procedure have become widely established, and have yielded a more accurate method for summarizing final data from a series of specimens.

So long as percentages were the only units recorded, there was no problem about the method of summarizing data. There was only one natural way, the aggregating and final averaging of percentages. Furthermore, in studies other than on upland gamebirds, there often is no practical alternative to percentages as the sole volumetric denominator since in many forms of wildlife the only feasible means of obtaining gross volumetric proportions is by visual estimate. In many species (e.g. passerine birds) the total food volume is so small that measurement of individual items is impractical. With ruminants and rodents the stomach contents often are so finely divided that segregation and mechanical measurement is too tedious, or the fragments are so small that separation is impossible; in all such cases, percentage estimates are the only practical course.

The greater ease, speed, and accuracy possible in analysis of crop contents, plus the superior reliability of their food-use indications, has led to omission of the gizzard contents in some studies; and in some others use of gizzards has been auxiliary for data on frequency of occurrence. Almost exclusive use of the crop as compared to gizzards helps to explain the prevalence of measurements by volume. Upland gamebirds feed largely on seeds, fruits, and other materials which while undigested in the crops are easily recognized and fairly readily separated; hence sorting out the items and measuring and recording their volumes (in cubic centimeters) have become almost standard procedure in this field of study. Offhand it might appear that visual estimates of proportions would provide an easier and more rapid method, but such is not necessarily the case if the results are to be reasonably accurate and the data of one investigator are to be closely comparable in accuracy with those of another. This becomes more apparent when it is realized that in upland gamebirds, generally the usual complex of items cannot be appraised readily and reliably either by estimate or by measuring devices without preliminary segregation.

It now is common practice in such

studies to make volumetric determinations of the various items in crops and to record these measurements on the record cards. Availability of these volumetric data has led to a newer method of summary. Instead of adding and averaging percentages, the more popular practice is to total the volume of each kind of food and use the total for any series of crops as a denominator to calculate the values for individual food items as percentages. It should be recognized, however, that practical application of this method is limited largely to studies in which volumes can be readily determined.

For convenience in reference, names will be applied which, though not fully definitive and distinctive, will serve present purposes. The practice of aggregating and averaging percentages may be termed the aggregate percentage method, while the procedure based on summing the measurements may be called the aggregate volume method.

DIFFERENCES IN RESULTS

If all birds in a series had exactly the same measured content of food, say 10 cc., then either method could be applied, with identical results. In actual practice, however, the volume of food varies with individuals and therein lies the source of the problem. In the aggregate percentage method, each bird eligible[2] for tabulation is accorded equality (100%) with all others; the variation in total volume of food present in any one bird accordingly does not influence the results. In the aggregate volume method, however, quantities actually present are used without adjustment relating to the total food in the individual.

TABLE 1.—SAMPLE RESULTS OBTAINED BY THE TWO METHODS.

Food items	Volume summation			Percentage summation			Final results by:	
	Bird A	Bird B	Total	Bird A	Bird B	Total	Aggregate volume	Aggregate percentage
Acalypha virginica	0.2 cc.	0.2 cc.	0.4 cc.	*10%*	*2%*	*12%*	$\frac{0.4 \text{ cc.}}{12 \text{ cc.}} = 3\%$	$\frac{12\%}{2 \text{ birds}} = 6\%$
Lespedeza stipulacea	1.8 cc.	9.8 cc.	11.6 cc.	*90%*	*98%*	*188%*	$\frac{11.6 \text{ cc.}}{12 \text{ cc.}} = 97\%$	$\frac{188\%}{2 \text{ birds}} = 94\%$
Subtotals			12 cc.			*200%*		

To illustrate the origin of differences on a very simplified scale, let us assume a situation involving the crops of two bobwhites, one (A) containing 2 cc. of food, and the other (B) 10 cc. Suppose that in both there is 0.2 cc. of *Acalypha virginica* and the remainder, 1.8 cc. in A and 9.8 cc. in B, consists of *Lespedeza stipulacea*. If the data from these two birds were tabulated by both methods the results would be as follows:

Aggregate Volume Method		*Aggregate Percentage Method*	
Acalypha	3%	Acalypha	6%
Lespedeza	97%	Lespedeza	94%

Some details of steps involved in the tabulations that yield these results are shown in Table 1.

[2] In tabulation of percentage for any given series it has been common practice to arbitrarily select and use only those stomachs or crops that were considered one-quarter or more full.

The extent of difference in these results depends, to some degree, on the viewpoint and basis of comparison. If, for *Acalypha*, the aggregate volume result (3%) is used as a basis then the aggregate percent method would give a rating twice as high *if regarded from the standpoint of this food alone*, or 3 per cent greater *if regarded from the standpoint of all (100%) food.* Conversely, if the aggregate percentage method served as a basis of appraisal, then the difference would be either 50 per cent or 3 per cent, depending on whether the perspective relates to a single food item or to total food. For *Lespedeza* the discrepancies would be similar except that they would be smaller.

Numerous series, large and small, ideal and average, and involving different species of upland gamebirds have been tested under both methods. The differences in results tend to be small when the final evaluation is obtained. In more or less ideal series with large numbers of individuals (100 or more) collected in the same locality and within a limited period there was an *average* difference of about 1 per cent, the extremes of difference generally ranged from zero to 5 per cent. In smaller and more typical series there was an average total food difference of about 2 per cent (extremes zero to 10%). Under either ideal or average conditions, however, the results, considered solely in respect to a single food item, often showed disparities of 100 to 300 per cent or more, especially among the lesser items.

RELATIVE MERITS

The many uncontrollable variables in food habits studies necessitate recognition of the resulting data as only roughly approximate in accuracy of implications; certainly they are too approximate to justify fractional percentages. In restricted series, the results are not likely to be dependable under any statistical method. It might, therefore, seem inconsequential as to which of the two methods for summarizing are employed on upland gamebird materials so long as both give results which are roughly similar. When one method is superior in ease and speed of operation and in quality of its data, however, there is no difficulty in making a choice.

The merits of the aggregate volume method are as follows: (1) There is a saving of time and labor. Basic units of data (measurements) are already available for direct assembly into final tabulations without taking the time and trouble to compute percentage equivalents for each volumetric determination with every bird. In medium and large series the saving by this factor of efficiency may be considerable. (2) The basic units, volumetric measurements, can be and are used in unaltered form, whereas the aggregate percentage method interposes interpretative adjustments by allowing 100 per cent parity to crops of varying volumetric content. (3) There is no need to give theoretical equality to stomach or crop content or to set an arbitrary limit to the contents (e.g., minimum crop, $\frac{1}{4}$ full) or to discard sub-limital crops (e.g., one only $\frac{1}{10}$ full, as commonly done in aggregate percentage tabulations.) In the aggregate volume method, items in nearly-empty crops are of negligible influence on the results, but record of

their occurrence may be desirable. (4) Each crop of large or small volume has its full influence on final results. The aggregate percentage method automatically suppresses the significance of full crops and magnifies that of lower-content crops.

These interpretative adjustments complicate and hamper later conclusions. The preferable course is to segregate data, on one basis or another (seasonal or sub-seasonal, locality, and possibly crop-volume) so that full significance is expressed for all specimens, whether gorged, average, or of low-content. Some low-content crops may reflect nibbling or sampling in areas where staple foods are absent; and distended crops obtained in seasons or localities having variety in available foods may express definite relish of a preferred food. Distended crops in winter may reveal other sorts of preference circumscribed by availability; stuffed crops in adverse weather may indicate dire necessity and little choice. These and similar interpretations on extent of use, preference, and availability are important in food studies on upland gamebirds. They can be obtained best by intelligent use of the aggregate volume method.

A question may be raised as to whether aggregate volume and aggregate percentage data in different studies are comparable. Is it appropriate to compare winter foods of bobwhite quail from two adjacent states if the data are obtained by the two divergent methods? In our opinion there should be no concern. There are many variables—adequacy and geographic representativeness of the specimens, fluctuations or periodicity in food availability and use, variations in individual methods of analysis—and other uncontrolled factors. These outweigh considerably the disparity in results from the two methods. Yet it is of interest and value in all food habits reports, that authors clearly indicate the statistical method used.

NUTRIENT CONTENT OF SOME WINTER FOODS OF RUFFED GROUSE

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In planning for the improvement and maintenance of suitable habitat for game species a knowledge of the composition of foods that enter into the diet of any particular species can be of assistance. A knowledge of the quantitative nutrient content of the different foods is important in evaluating the significance of various food components in the environment.

The principal sources of information on the nutrient composition of wildlife foods are compilations, and many are not comprehensive. Winton and Winton (13), Wehmer (12), and Morrison (7) have presented extensive lists of feedstuffs with their proximate composition but only recently have more extensive data been reported that are directly applicable to wildlife manage-

ment; chief among these are the data of Waino and Forbes (11), King and McClure (5), Lund and Sandstrom (6), Bailey (2), and Fudge and Fraps (4).

The work here reported was undertaken to supply basic information and to complement the information obtained by Nelson, Clarke and Bailey (8) in management studies on ruffed grouse (*Bonasa umbellus*) in the George Washington National Forest, Virginia. The choice of food in winter is restricted to fewer kinds and there is considerable variation in availability depending on weather conditions; hence our study was to determine the nutrient content of food items prominent in the winter dietary of this bird.

TABLE 1.—IMPORTANT WINTER FOOD PLANTS OF RUFFED GROUSE COLLECTED AND ANALYZED.

Name	*Portion analyzed*
Alder (*Alnus*)[a]	Catkins
Serviceberry (*Amelanchier canadensis*)[b]	Buds
Yellow birch (*Betula lutea*)[b]	Buds
Hazelnut (*Corylus rostrata*)[a]	Catkins
Trailing arbutus (*Epigaea repens*)[a]	Leaves
Galax (*Galax aphylla*)[a]	Leaves
Wintergreen (*Gaultheria procumbens*)[a]	Leaves
Mountain laurel (*Kalmia latifolia*)[b]	Flower buds
Mountain laurel (*Kalmia latifolia*)[a]	Leaves
Menziesia (*Menziesia pilosa*)[c]	Buds
Partridgeberry (*Mitchella repens*)[a]	Leaves
Christmas fern (*Polystichum acrostichoides*)[a]	Leaves
Selfheal (*Prunella vulgaris*)[a]	Leaves
Rose (*Rosa humilis*)[a]	Fruit
Sheep sorrel (*Rumex acetosella*)[b]	Leaves
Greenbrier (*Smilax glauca*)[a]	Leaves
Greenbrier (*Smilax glauca*)[a]	Fruit

[a] Collected March 6 to March 9, 1942, on The George Washington National Forest, Augusta County, Virginia.
[b] Collected March 3, 1944, on the Patuxent Research Refuge, Prince Georges County, Maryland.
[c] Collected March 14, 1944, at Mountain Lake, Giles County, Virginia.

SCOPE AND PROCEDURE

Samples of 17 foods which stomach examinations showed were used rather extensively during the winter in the George Washington National Forest were collected from March 3 to 14 in 1942 and 1944 (Table 1).

As soon as practical after collection, the samples were weighed and dried for 60 hours at 65°C., then placed in room air for 24 hours to reach moisture equilibrium. After the latter exposure they were ground in a Wiley mill and sealed in glass bottles.

The analytical procedures were those in "Methods of Analysis of the Association of Official Agricultural Chemists" (1) except for phosphorus where the method of Stoloff (9) was followed. Moisture as reported indicates the percentage of weight lost in drying under specified conditions. Percentage total nitrogen times the factor 6.25 represents protein; in addition to true protein nitrogen, it includes all nitrogen contributed by free amino acids, peptides, and certain other nitrogen containing compounds. Carbohydrate is computed as the difference between 100 and the sum of the percentages of moisture, protein, ether extract and ash. It includes crude fiber, starch, dextrin, sugars, and other undetermined solids. Crude fiber gives an approximate measure of the fibrous portion of the plants; digestion of this by gallinaceous birds is so slight that it can be considered indigestible (3), (10). Nitrogen free extract is the total carbohydrate less the crude fiber fraction, a measure of the available carbo-

hydrate. Ether extract includes not only true fats but other ether soluble substances such as fatty acids, waxes, and plant pigments. Ash is the residue from burning the dry substance until free of carbon, and includes calcium, phosphorus, and other inorganic elements, many of which are necessary for proper nutrition. Calcium and phosphorus are expressed as the elements, and are included in the analyses because of their importance in skeletal development and in reproduction. Gross energy is computed from the organic nutrients present, using average calorific values of 4.1 calories per gram for carbohydrate; 9.45 calories per gram for fat, and 5.65 calories per gram for protein. The predominant role of food during the winter is the production of energy for body processes, and the energy value provides a common basis for expressing the nutritive value of all organic nutrients.

RESULTS

Tables 2 and 3 show the composition of the food items, on a dry basis in the former and on a fresh basis in the latter. In considering the nutritive value of individual items, account must be taken of the fact that moisture is a diluent and any comparison of the different items should be on a moisture free basis. Increased energy requirements for maintenance during the winter to compensate for the greater heat loss then directs attention to those foods providing the least dilution in the natural state.

Of the seventeen items in Table 2, there are 15 plants represented: 7

TABLE 2.—COMPOSITION OF SOME FOODS OF RUFFED GROUSE.
(Moisture free basis; all figures are percentages except last column.)

Food	Protein	Ether extract	Carbohydrate		Ash	Calcium	Phosphorus	Gross energy, cal./gm.
			Crude fiber	Nitrogen free extract				
Alnus (catkins)	16.6	12.8	17.2	49.8	3.7	0.436	0.223	4.9
Amelanchier candensis (buds)	7.8	9.0	21.6	53.6	8.0	0.299	0.414	4.4
Betula lutea (buds)	9.3	2.5	33.0	39.1	5.5	1.710	0.222	3.7
Corylus rostrata (catkins)	15.0	2.4	18.4	58.7	5.5	1.072	0.263	4.2
Epigaea repens (leaves)	7.7	7.1	19.0	63.0	3.1	0.514	0.087	4.5
Galax aphylla (leaves)	9.2	3.3	13.4	69.8	4.3	0.785	0.107	4.2
Gaultheria procumbens (leaves)	6.1	8.4	17.2	63.9	4.5	1.228	0.074	4.5
Kalmia latifolia (flower buds)	6.9	20.9	12.9	56.5	2.8	0.536	0.192	5.2
Kalmia latifolia (leaves)	8.1	11.1	15.6	62.2	3.0	0.806	0.091	4.7
Menziesia pilosa (buds)	8.2	6.0	17.5	63.1	5.3	1.194	0.193	4.3
Mitchella repens (leaves)	8.4	3.4	12.1	71.1	5.0	0.846	0.092	4.2
Polystichum acrostichoides (leaves)	10.3	4.8	18.3	60.2	6.3	0.569	0.131	4.3
Prunella vulgaris (leaves)	12.2	3.5	7.9	65.0	11.4	0.800	0.271	4.0
Rosa humilis (fruit)	7.9	4.3	36.8	46.9	4.0	0.647	0.140	4.3
Rumex acetosella (leaves)	20.6	4.0	7.9	62.7	4.7	1.709	0.232	4.4
Smilax glauca (leaves)	10.8	10.4	15.6	59.4	3.8	0.757	0.135	4.7
Smilax glauca (fruit)	9.1	7.6	14.9	65.4	3.1	0.187	0.144	4.5

herbaceous, 6 shrubs, one vine, and one tree.

All of the foods have their dry substance principally of carbohydrate. With two exceptions (*Betula lutea* buds and *Rosa humilis* fruits), this consists largely of nitrogen free extract. The cellulose and related compounds classed as crude fiber have little or no food value; and foods may be expected to vary in nutritive value in direct proportion to their crude fiber content. The nitrogen free extract is a readily available source of energy, necessary for the maintenance of life during severe weather.

Protein, while not a predominant constituent in the foods, is present in a quantity normally found in plants and at a level that should permit the bird to maintain or add to its protein stores. If the proteins in the grouse foods named are not materially different in quality from other known plant proteins, then grouse should experience no difficulty in maintaining their protein balance during the winter when access can be had only to the listed food plants.

The fat content of the various foods, as represented by the ether extract fraction, varies considerably; it contributes an important share of the total energy available for maintenance. Considerable variation may be expected, however, in the nutritive contribution of ether extract due to the inclusion of indigestible waxes in this fraction. This is particularly true for waxy plant foods such as flower buds and some leaves.

Mineral matter represented by the ash value contributes towards the proper nutrition of the bird only in supplying those minerals needed for replacing body mineral stores lost in metabolism or in the building up of reserves. The ash constituents, calcium and phosphorus, are essential for proper growth and reproduction, but are not essential for survival during periods of adverse weather when the primary requirement is energy. The amounts present in the foods are sufficient, if

TABLE 3.—COMPOSITION OF SOME FOODS OF RUFFED GROUSE.
(Fresh basis; all figures are percentages except last column.)

Food	Moisture	Protein	Ether extract	Carbohydrate		Ash	Calcium	Phosphorus	Gross energy, cal./gm.
				Crude fiber	Nitrogen free extract				
Alnus (catkins)	49.4	8.4	6.5	8.7	25.2	1.9	0.220	0.113	2.48
Amelanchier candensis (buds)	50.6	3.9	4.5	10.7	26.4	3.9	0.148	0.204	2.16
Betula lutea (buds)	31.3	6.4	1.7	22.7	26.9	3.8	1.175	0.152	2.56
Corylus rostrata (catkins)	52.7	7.1	1.1	8.7	27.8	2.6	0.507	0.125	2.00
Epigaea repens (leaves)	48.3	4.0	3.7	9.8	32.6	1.6	0.266	0.045	2.32
Galax aphylla (leaves)	57.0	3.9	1.4	5.8	30.0	1.9	0.338	0.046	1.82
Gaultheria procumbens (leaves)	55.3	2.7	3.7	7.7	28.5	2.0	0.549	0.033	1.99
Kalmia latifolia (flower buds)	51.2	3.4	10.2	6.3	27.6	1.4	0.262	0.094	2.54
Kalmia latifolia (leaves)	54.2	3.7	5.1	7.2	28.4	1.4	0.369	0.042	2.15
Menziesia pilosa (buds)	35.3	5.3	3.8	11.3	40.8	3.4	0.772	0.125	2.80
Mitchella repens (leaves)	32.0	5.7	2.3	8.2	48.4	3.4	0.576	0.063	2.86
Polystichum acrostichoides (leaves)	62.0	3.9	1.8	7.0	22.9	2.4	0.216	0.050	1.62
Prunella vulgaris (leaves)	73.2	3.3	0.9	2.1	17.4	3.0	0.214	0.073	1.08
Rosa humilis (fruit)	21.5	6.2	3.4	28.9	36.8	3.2	0.508	0.110	3.37
Rumex acetosella (leaves)	83.4	3.4	0.7	1.3	10.4	0.8	0.284	0.038	0.74
Smilax glauca (leaves)	54.6	4.9	4.7	7.1	27.0	1.7	0.343	0.611	2.12
Smilax glauca (fruit)	27.7	6.6	5.5	10.8	47.3	2.3	0.135	0.104	3.27

properly utilized, to maintain the bird in mineral balance and may permit an increase in the reserves.

Other nutrients of value in grouse foods which permit the proper functioning of physiological processes and which must be considered are the vitamins. No determinations were made on the amounts of the various vitamins present in the more important grouse foods. There is good reason to believe, however, that the nature of the foods eaten —seeds, buds, and green leafy parts— should not involve any scarcity of vitamins.

The nutrient composition of the foods (Table 2) shows they are particularly suited as sources of energy and other nutrients needed by grouse during the winter. These fundamental data substantiate the results of grouse management studies which have shown that grouse can pass through a winter season and maintain themselves in a good nutritional condition when they have access to such foods.

The grouse foods have also been calculated to a fresh basis (Table 3) to show their general composition as they exist when used by the birds. These data reveal the extent to which the nutrients are diluted with water and the effect this has on the relative position one food item occupies with respect to others when any particular nutrient is considered. It must be borne in mind, however, that the moisture content of foods found in the wild is not constant; it will vary in any particular item depending upon environmental conditions existing when the food is taken, and upon the stage of growth. Grouse, with their relatively high food capacity, fortunately are capable of ingesting sufficient quantities of the more diluted foods to obtain enough nutrients to maintain themselves in a satisfactory state.

SUMMARY

Seventeen preferred grouse foods were collected during the late winter and analyzed for nutrient content. The results include moisture, crude protein, ether extract, crude fiber, nitrogen-free extract, ash, calcium, phosphorus, and gross energy content expressed both on moisture free and fresh bases.

The preferred winter foods of grouse are characterized by a high content of dry substance and of nitrogen-free extract.

On the basis of nutrient content, the foods examined are well qualified as sources of energy and other essential nutrients required for maintenance of grouse during the winter season.

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FOOD OF MAINE RUFFED GROUSE BY SEASONS AND COVER TYPES[1]

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Food habits of ruffed grouse (*Bonasa umbellus togata*) in Maine were studied from October 1941 to September 1943. Most of the grouse were taken during the hunting seasons (Oct. 1–Nov. 15) of 1941 and 1942, but limited collections were made throughout the year, and in all counties except Oxford; 265 digestive tracts were obtained. The study was designed to learn the seasonal food habits and the relationship between foods eaten and food availability.

METHODS

To obtain data on cover, selected cooperators throughout the State were supplied with numbered mimeographed forms to record the date, locality, and sex of each bird collected, and detailed information on the forest cover, shrubs, and ground cover in the locality where the grouse was killed. Numbered celluloid tags corresponding with the cover data forms were attached to the digestive tracts. Thus, when the preserved digestive tracts reached the laboratory, it was possible to associate the crop and gizzard of each bird with the corresponding field data sheet.

The crop contents were identified and each item measured volumetrically (to 0.1 ml.); the gizzard contents were

[1] Contribution from Maine Cooperative Wildlife Research Unit, Orono, Maine; Maine Department of Inland Fisheries and Game, University of Maine, American Wildlife Institute, and U. S. Fish and Wildlife Service, cooperating. Howard L. Mendall, Unit Leader, gave valuable assistance and advice throughout the study. Aid in identification of food was given by the Department of Botany and Entomology at the University of Maine, and by A. C. Martin, F. M. Uhler, Robert Stewart, and Lawrence Saylor of the U. S. Fish and Wildlife Service.

recorded only by occurrence. In freshly killed birds, the materials were segregated, identified, and immediately measured in a graduated cylinder by water displacement. With preserved crops, the material was examined in water in a white enameled pan, and then dried to approximately the natural moisture content before measurement.

The volume was totalled for each food in the crops for each season and cover type. Percentages were obtained by dividing the volume of each kind of food by the combined total for all food taken in that season or type. Grit was recorded separately as a percentage of the total volume of the crop contents. This method of tabulation gives somewhat different results from that of averaging percentages as used in many previous food habits studies. For gallinaceous birds, however, the present method appears to show the importance of various food items concerned with greater accuracy. Its advantages are more completely described by Martin, Gensch, and Brown (1946).

SEASONAL FOOD HABITS

Autumn was defined as September 16 to November 30; winter, December 1 to March 31; spring, April 1 to June 15; and summer, June 16 to September 15. The average date when snow makes ground cover unavailable to grouse in north-central Maine was selected as the beginning of winter; April 1 the date when the birds could again obtain an abundance of leaves from evergreen ground cover; June 16, when new leaves, insects, and early wild fruits became abundant; and September 16 when insects and summer fruits had largely disappeared. No crops were obtained from May 15 to July 1, thus detracting somewhat from the food tabulations for the spring and summer (Table 1).

AUTUMN FOODS

Hazelnut. This was most preferred, occurring in 57 of the 188 crops, and forming 14.8 per cent of the food for the season. Kittams (1943) listed no hazelnut in his tabulation of October foods, but the situation might have been altered had his data included more crops. Gross (1937) found hazelnut in 140 of 1,055 crops, comprising 1.14 per cent of the total volume; only 156 of his birds were taken in Maine. Kuhn (1941) found only 1.66 per cent in the November food in Pennsylvania. Why Maine grouse exhibit such fondness for hazelnut is not clear, since the plant is also common in other eastern states.

Clover. Leaves and stems occurred in 94 crops, making 13.3 per cent of the diet. This plant is available in or near practically every type of cover inhabited by grouse. Kittams found it the most important October food in Maine, comprising 13.4 per cent. It appears more important in Maine than in many other states, although Knowlton, Pillsbury, Dole, and McGregor (1940) in New Hampshire found that white clover (*T. repens*) provided 20.3 per cent of the October food. Kuhn found there was little (0.12%) in the November grouse diet in Pennsylvania, as did Nelson, Clarke, and Bailey (1938) in Virginia (0.47% early winter). Darrow (1939) did not record clover as important in any part of New York State.

Apple. Apple trees are common about abandoned farms and to a lesser extent in forest margins. Fruit and buds were found in 25 crops comprising 11.1 per cent. Kittams listed apple fifth in Octo-

ber foods (5.1% of all), and Gross as 3.43 per cent of the diet in New England. Knowlton, *et al.* (1940) reported 34.5 per cent for October in New Hampshire, and 20 per cent in November. Still other studies indicate apple as an important food when available.

Hawthorn. Hawthorn thickets are favored autumn feeding spots. The trees are abundant on abandoned farm lands, in old pastures, along hedgerows, and in wood-edges where the fruit is ordinarily available into early winter. Fruits occurred in but 20 crops, but made 10.8 per cent of the autumn food. Gross listed *Crataegus* as 7.30 per cent of the food in New England, and Kittams 9.7 per cent in the October diet in Maine. In Pennsylvania, hawthorn accounted for 9.26 per cent of the November food reported by Kuhn. In New Hampshire hawthorn was second only to apple as an October food, (10.2% of total) according to Knowlton, *et al.* Although not necessarily significant, there is close similarity in the percentages in these several studies.

Aspen. Both large-toothed and trembling aspens are common throughout Maine. Leaves and some buds made 7.6 per cent of the autumn diet. Kuhn found this the most important November food in Pennsylvania during 1939 (17.3%), but Merrits (1943) listed only 8.2 per cent for November 1940 in that state. In Maine, Kittams reported *Populus* as providing 12.2 per cent of the food in October 1941. The consumption apparently varies considerably in any locality from year to year.

WINTER FOODS

Aspen. The "budding" habit of ruffed grouse is well known to persons afield in winter. The birds often feed in aspens, sometimes at considerable heights, just at daybreak or dusk. Buds of the large-toothed and trembling aspens comprised 54.8 per cent of the winter diet. Kelso (1935) found buds and twigs (12.5%) the most important winter food in New York, but Darrow indicated aspen as second to birch as winter food in that state.

Willow. The buds and leaves, particularly those of the common pussy-willow (*S. discolor*), were second in importance; they occurred in 16 crops; and made 8.8 per cent of the diet. Merrits (1943) is the only other worker whose data were available during the present study who found this plant of much importance to grouse; in 112 crops, she found willow to comprise 8.4 per cent of the food in Pennsylvania during November 1940.

Hazelnut. The usage of hazelnut as grouse food diminished during the winter, yet it accounted for 7.3 per cent of the total, with catkins and buds in 11 crops. Nelson, Clarke, and Bailey found it comprising only 1.2 per cent of the early winter food on the George Washington National Forest in Virginia; and Kelso indicated *Corylus* as unimportant during the winter in New York.

Wild cherry. Fruits (chiefly *P. virginiana*) made less than 1 per cent of the autumn diet, but in winter the buds represented 5.3 per cent. Buds and twigs were identified in 9 crops. Kelso found that wild cherry formed 8.9 per cent of the winter sustenance of grouse in New York, becoming more important as the season advanced. A similar condition was found in the present study, wild cherry becoming more important from December to February.

TABLE 1.—MOST IMPORTANT FOODS OF THE RUFFED GROUSE IN MAINE, BY SEASONS.

	Occurrence, number of crops	Total volume, cc.	Percentage of total volume
AUTUMN (188 specimens)			
Hazelnut (*Corylus*)	57	362.8	*14.8*
Clover (*Trifolium*)	94	325.9	*13.3*
Apple (*Pyrus*)	25	273.0	*11.1*
Hawthorn (*Crataegus*)	20	264.8	*10.8*
Aspen (*Populus*)	21	186.3	*7.6*
Wild raisin (*Viburnum cassinoides*)	14	89.1	*3.6*
Sumac (*Rhus*, chiefly *R. typhina*)	1	75.0	*3.1*
Birch (*Betula*)	33	70.9	*2.9*
Wintergreen (*Gaultheria procumbens*)	34	70.1	*2.9*
Beech (*Fagus grandifolia*)	10	65.7	*2.7*
Wood sorrel (*Oxalis*)	25	59.4	*2.4*
Arrow-wood (*Viburnum dentatum*)	1	53.5	*2.2*
Rose (*Rosa*)	4	52.9	*2.2*
Highbush cranberry (*Viburnum opulus*)	5	43.5	*1.8*
Gill fungi (Agaricales)	5	38.8	*1.6*
Winterberry (*Ilex verticillata*)	8	37.7	*1.5*
Other plant food (69 species, etc.)		369.2	*15.5*
Total plant food		2438.6	99.4
Total animal food		14.4	0.6
TOTAL ALL FOOD		2453.0	
WINTER (47 specimens)			
Aspen	33	954.7	*54.8*
Willow	16	154.0	*8.8*
Hazelnut	11	126.6	*7.3*
Wild cherry	9	93.1	*5.3*
Apple	11	74.0	*4.3*
Sumac (*Rhus typhina*)	5	69.6	*4.0*
Serviceberry (*Amelanchier*)	7	54.9	*3.2*
Hawkweed (*Hieracium*)	2	35.5	*2.0*
Blueberry (*Vaccinium*)	8	29.2	*1.7*
Birch	7	27.0	*1.5*
Wintergreen	10	22.5	*1.3*
Other plant food (34 species)		101.9	*5.8*
TOTAL FOOD		1743.0	
SPRING (23 specimens)			
Aspen	17	594.3	*71.4*
Wild strawberry (*Fragaria*)	15	50.0	*6.0*
Birch	6	37.8	*4.5*
Willow	6	30.2	*3.6*
Wintergreen	4	20.6	*2.5*
Shinleaf (*Pyrola*)	7	17.6	*2.1*
Hawkweed	3	17.1	*2.1*
Unidentified leaves	9	13.1	*1.6*
Canada mayflower (*Maianthemum canadense*)	3	10.7	*1.3*
Hazelnut	2	9.1	*1.1*
Other plant food (24 species)		27.2	*3.2*
Total plant food		827.7	99.4
Total animal food		4.6	0.6
TOTAL ALL FOOD		832.3	

TABLE 1—*Continued*

	Occurrence, number of crops	Total volume, cc.	Percentage of total volume
SUMMER (7 specimens)			
Elderberry (*Sambucus*)	1	11.0	53
Blueberry	2	4.5	22
Raspberry (*Rubus*, mostly *R. idaeus*)	5	2.1	10
Red maple (*Acer rubrum*)	1	1.0	5
Sheep sorrel (*Rumex acetosella*)	1	.8	4
Goldthread (*Coptis groenlandica*)	3	.2	1
Wintergreen	2	.2	1
Clover	2	.2	1
Other plant food (9 species)		.1	
Total plant food		20.1	97
Total animal food		0.6	3
TOTAL ALL FOOD		20.7	

Apple. The chief winter use shifted from fruit to buds. Fruit or buds were present in 11 of 47 crops and made up 4.3 per cent of the total. In New York Kelso found twigs and buds formed about 6 per cent of the winter diet, and Darrow listed this food as seventh among the 10 most important winter food plants

SPRING FOODS

The tabulation of spring foods is based on 23 crops. More buds and catkins were present than if collections had included crops obtained in late May and early June. The proportion of leaves also might have been increased materially by later collections. More specimens taken in spring and summer would have increased the value of the data, but it was considered inadvisable to take birds during the nesting and early brood seasons; food is rarely a limiting factor at that time.

Various buds and catkins provided over three-fourths of the winter food, and continued to be of prime importance in early spring. Thus "budding" by grouse is not confined to late autumn and winter, but continues after the snow has disappeared. Leaves and fruit of certain ground cover plants, however, became more important as spring progressed.

Aspen. Buds and catkins of both trembling and large-toothed aspen were utilized in spring in even greater amounts (71.4%) than during the winter. The relative value of aspen may be somewhat exaggerated in this study, since many spring specimens were collected in early morning and late afternoon, when grouse appear habitually to fill their crops with bulky material. Buds of both willow and aspen are greatly swollen at this season. Aspen is far the most important spring food in Maine. Darrow listed *Populus* as the most important spring food in all parts of New York except the Catskill Mountains, where it ranked second to *Betula.*

Wild strawberry. The rosette leaves of wild strawberry are more or less green throughout the winter; when exposed in the spring they are taken by

TABLE 2.—ANNUAL DIET OF RUFFED GROUSE IN MAINE. Percentage of total volume.

PLANT FOOD	
Aspen (*Populus*)	34.3
Hazelnut (*Corylus*)	9.9
Apple (*Pyrus*)	6.9
Clover (*Trifolium*)	6.6
Hawthorn (*Crataegus*)	5.2
Willow (*Salix*)	3.7
Sumac (*Rhus*)	2.9
Birch (*Betula*)	2.9
Wintergreen (*Gaultheria procumbens*)	2.2
Wild cherry (*Prunus*)	2.2
Wild raisin (*Viburnum cassinoides*)	1.8
Beech (*Fagus grandifolia*)	1.3
Wood sorrel (*Oxalis*)	1.2
Wild strawberry (*Fragaria*)	1.2
Hawkweed (*Hieracium*)	1.2
Arrow-wood (*Viburnum dentatum*)	1.1
Serviceberry (*Amelanchier*)	1.1
Rose (*Rosa*)	1.0
Blueberry (*Vaccinium*)	1.0
High-bush cranberry (*Viburnum trilobum*)	0.9
Gill fungi	0.8
Winterberry (*Ilex verticillata*)	0.8
Ferns (chiefly *Dryopteris*)	0.8
Canada mayflower (*Maianthemum canadense*)	0.8
Club-moss (*Lycopodium*)	0.7
Chokeberry (*Pyrus*)	0.7
Dogwood (*Cornus*, largely *C. canadensis*)	0.6
Cinquefoil (*Potentilla*)	0.5
Maple (*Acer*)	0.5
Shinleaf (*Pyrola*)	0.5
Undetermined	0.5
Buttercup (*Ranunculus*)	0.4
Sheep sorrel (*Rumex acetosella*)	0.3
Rhodora (*Rhododendron canadense*)	0.3
Fir (*Abies balsamea*)	0.2
False Solomon's seal (*Smilacina*)	0.2
Huckleberry (*Gaylussacia baccata*)	0.2
Red oak (*Quercus borealis*)	0.2
Raspberry (*Rubus*)	0.2
Goldenrod (*Solidago*)	0.2
Sheep laurel (*Kalmia angustifolia*)	0.2
Avens (*Geum*)	0.2
Elderberry (*Sambucus*)	0.2
Partridge berry (*Mitchella repens*)	0.1
Spiraea (*Spiraea*)	0.1
False miterwort (*Tiarella cordifolia*)	0.1
Honeysuckle (*Lonicera*)	0.1
Beech-drops (*Epifagus virginiana*)	0.1
Northern white pine (*Pinus Strobus*)	0.1
Sedge (*Carex*)	0.1
Goldthread (*Coptis groenlandica*)	0.1
Twin-flower (*Linnaea borealis*)	0.1
Poison ivy (*Rhus radicans*)	0.1

grouse in considerable quantities. The plant is abundant in fields, along wood roads, and in open woodland, and apparently is an important source of green food early in the spring. Leaves occurred in 15 of 23 spring crops, furnishing 6.0 per cent of the food. *Fragaria* was listed by Darrow as among the 10 most significant spring foods in New York and the only non-woody plant of particular note besides *Oxalis* and *Thelypteris*.

Birch. Buds and catkins of birch were third in the spring food, forming 4.5 per cent of the total, a noticeable increase over that in the winter. *Betula*, according to Darrow, is of primary importance in the Catskill Mountains during the spring, and second to *Populus* elsewhere in New York.

Willow. Buds of willow occurred in about 34 per cent of the crops taken in winter, and in 26 per cent of those taken in spring. In the diet of the grouse, however, they amounted to 8.8 per cent of the total in winter and 3.6 per cent in spring. Darrow did not list willow among the 10 most important spring food plants in New York.

Wintergreen. Leaves were found in 4 of 23 spring crops, making 2.5 per cent of the food. This perennial is locally common, and the leaves remain green throughout the winter; hence it is one of the few green foods available before the growing season.

SUMMER FOODS

No birds were killed in June, and only seven in all during late July, August, and the first half of September. The information from these is so meager as not to warrant conclusions on summer food habits in Maine as a whole.

Darrow examined summer crops of 85 adults and 332 chicks in New York.

Animal food in chicks comprised 46.8 per cent of the June diet in the Adirondacks, and 68.3 per cent in the Catskills, but in adults scarcely 3 per cent in the Adirondacks, and less than 1 per cent in the Catskills. Of plant materials eaten by adults, *Rubus* and *Carex* were most important in the Adirondacks, and *Rubus* and *Prunus* in the Catskills.

Knowlton, *et al.* examined 17 crops taken in New Hampshire from June 14 to July 13, and 14 from July 14 to July 30, 1940. In the earlier period, wild strawberry was first in importance (60% of total volume) and touch-me-not (*Impatiens biflora*) second (5.6%). During the second period achenes of *Carex* were first (23.8%), and various insects furnished 16.6 per cent of the food. Those authors also examined 20 crops for the period from July 31 to September 30; raspberry and blackberry (*Rubus*) provided 25.5 per cent and slugs (*Limax*) 10.7 per cent of the food.

Cover Types and Food Habits

Detailed cover maps were available for only a few areas and each collection was assigned to a general type from information on the cover-data sheets. These data were segregated into five types by the arborescent, shrubby, and herbaceous plants of most frequent occurrence, as follows:

1. *Mixed growth, hardwoods predominating.* Trees: gray and white birch, spruce, fir, aspen, and yellow birch. Shrubs: hazelnut, wild raisin, raspberry, blackberry, and elderberry. Ground cover: bunchberry, ferns, clover, wild strawberry, and wintergreen.

2. *Mixed growth, softwoods predominating.* Trees: spruce, gray and/or white birch, fir, maple, white pine, and aspen. Shrubs: hazelnut, raspberry, wild raisin, red-stemmed dogwood, and blueberry. Ground cover: bunchberry, wild strawberry, partridge berry, ferns, and wintergreen.

3. *Upland hardwoods.* Trees: yellow birch, sugar maple, beech, white birch, aspen, and spruce. Shrubs: raspberry, sumac, wild raisin, witch-hobble, and hazelnut. Ground cover: wintergreen, bunchberry, celandine, strawberry, and shinleaf.

4. *Lowland hardwoods.* Trees: alder, gray and/or white birch, soft maple, aspen, spruce, and willow. Shrubs: blackberry, hazelnut, raspberry, and red-stemmed dogwood. Ground cover: partridge berry, bunchberry, wintergreen, violet, and sedge.

5. *Old fields and orchards.* Trees: apple, gray and white birch, alder, spruce, hawthorn, aspen, and white pine. Shrubs: sumac, raspberry, blueberry, hazelnut, and winterberry. Ground cover: grasses, clover, hawkweed, aster, goldenrod, and sheep sorrel.

The principal foods are discussed for each of these five types.

MIXED GROWTH, HARDWOODS PREDOMINATING

The data for this type are based on 71 crops.

Aspen. The large-toothed aspen (*P. grandidentata*) and trembling aspen (*P. tremuloides*) are the prime sources of grouse food, slightly over 45 per cent. The leaves are most important in autumn, and buds in winter and spring. Both species occur throughout Maine, and the balsam poplar (*P. tacamahacca*) occurs locally.

Hazelnut (*Corylus*). The beaked hazelnut (*C. cornuta*) is statewide in distribution, and the American hazelnut (*C. americana*) is found in the southern half of Maine. Both are thicket-forming plants, abundant on favorable sites. The former is the most common shrub in this forest type, and *Corylus* furnishes more grouse food than any other shrub.

Hazelnut is quite tolerant of shade, but rarely produces fruit except in the more open locations. The catkins are utilized most as food by grouse, but buds are taken freely. These parts made 12.7 per cent of the diet in this cover type. None of the crops examined during this study contained the fruit of hazelnut.

Willow. Buds and leaves (chiefly *S. discolor*) furnished 4.5 per cent of the food. Willows are infrequent in this type, and a part of this food probably was obtained from in nearby lowlands and stream courses.

Clover. Leaves formed 4.5 per cent of the diet, being of greatest importance in summer and early autumn. The wide distribution of clover in remote sections probably results mainly from the logging and pulpwood industries. The seed was apparently distributed from hay hauled into the forest for horse feed, and from horse droppings. Clover is not uncommon in this cover type, but the degree of utilization seems inconsistent with its availability, since several other ground cover plants, including bunchberry, ferns, and perhaps wintergreen, are of more frequent occurrence. Hence, clover appears to be chosen by grouse in preference to other herbs.

Wild cherry. Fruit, buds, and leaves made 2.7 per cent of the food; the buds, chiefly in winter, accounted for the bulk of this material. Black cherry (*P. serotina*) occurs in rich woodland, but is not usually common. Fire cherry (*P. pensylvanica*) is found in old burns, in open woods, and along fences and roadsides. Choke cherry (*P. virginiana*) likewise favors fencerows, roadsides, and forest edges.

Wood sorrel (*Oxalis*). This plant (chiefly *O. montana*) is locally abundant. The leaves are taken primarily in autumn and made 2.5 per cent of the diet. It is usually of irregular distribution in any locality, and its utilization by grouse seems nearly in proportion to availability. The use in summer may be higher.

MIXED GROWTH, SOFTWOODS PREDOMINATING

Sixty-two crops were available from this cover type.

Aspen. The percentage taken was 53.8 per cent in areas where softwoods outnumbered hardwoods. This is of interest, because there is less aspen in this type. Although some feeding is done here, the chief value of softwoods to grouse is as shelter or resting cover, particularly in late autumn and winter. This was pointed out by Bump (1938) in New York, and by Hosley (1940) in New Hampshire. The apparent high value of aspen among mixed conifers may represent feeding along margins of clearings and roadsides, and even in another cover type. Aspens available in this type may be subjected to heavy feeding by the grouse, due to the proximity of roosting cover.

Hazelnut. Grouse appear to feed

upon hazelnut under softwoods in proportion to its availability, since it is among the commonest shrubs present. Catkins and buds furnished 8.5 per cent of the total diet.

Clover. Clover (5.8%) appears third on the food list. The grouse may have obtained this food along wood roads, or in other adjacent cover, but both sources probably are of importance. Clover is seldom common in unbroken stands dominated by softwoods. Assuming that part of the clover was obtained in roads and clearings, the fact that it was taken in such large amounts would indicate decided preference by grouse.

Wild cherry. Furnishing 3.6 per cent of the food, wild cherry appears to be of slightly greater importance here than in hardwood-dominated mixed growth. It is not very common in either type, and the amount of usage indicates that grouse prefer cherry to more abundant foods, such as white birch.

Serviceberry. This plant contributed 3.3 per cent of the diet, largely as buds during winter and early spring. The fruit is probably of some importance in June and July. *Amelanchier* occurs both in arborescent and shrubby forms, and is frequent in open woodland, along forest margins, and on calcareous sites.

Birch. Buds, catkins, and leaves, chiefly of yellow birch (*B. lutea*), made 2.3 per cent of the food. This is somewhat more than would be expected because of the limited occurrence of yellow birch in softwood-dominated woodland, but the discrepancy between availability and usage is not enough to conclude that any appreciable quantity, of buds and catkins was obtained elsewhere.

UPLAND HARDWOODS

Data in this cover type were obtained from 23 crops.

Aspen. The volume of buds and leaves taken is not in proportion to the availability of this food. Aspens are less common than yellow birch, sugar maple, and beech, yet account for 35.1 per cent of the food. This must indicate preference for this food, because upland hardwoods are not inhabited by grouse to any extent in winter—when buds are the chief source of sustenance—save for feeding.

Clover. Grouse exhibit a preference for clover plants, but it seems unlikely that the position of *Trifolium* in second place for the type (15.2% of the total) is representative of extensive upland hardwood cover as a whole. Much of the clover probably was taken along roads and in clearings, where the plant is common. Large tracts of hardwoods without openings would have little clover.

Wintergreen. This shrub is the commonest ground cover in upland hardwoods, with the possible exception of bunchberry, and contributes 8.1 per cent of the food.

Birch. The birches exhibit their greatest importance as grouse food in the upland hardwood type, buds and staminate catkins of both yellow and white birch forming the chief contribution (7.4% of the total). As with aspen, birches are sought out by grouse while on feeding excursions from their shelter cover.

Hazelnut. It is most significant that hazelnut is of universal importance in all cover types. Buds and catkins comprised 6.6 per cent of the food in upland hardwoods, and 8 per cent or more in each of the other types on an annual

basis; higher proportions were eaten during late autumn and winter.

Beech. Fruits and buds account for 5.5 per cent of the annual food from upland hardwoods. Of 265 crops examined during the entire study, only 11 contained nuts and one held buds.

Beechnuts are probably of greater consequence locally in autumn than the present study indicates, but the crop is erratic, heavy seed production occurring at irregular intervals.

Other foods. Hawthorn is universally important as a grouse food, and even in the upland hardwoods, supplied 4.8 per cent of the annual diet. In addition, apple contributed 4.4 per cent, club-moss 3.3 per cent, winterberry 3.0 per cent, and wood sorrel 2.0 per cent.

LOWLAND HARDWOODS

Data were obtained from 27 crops.

Aspen. Trees are moderately common in lowland hardwoods, where grouse ate buds and leaves to make 22.2 per cent of the annual diet. Aspens furnish a greater volume of food than any other plant in every cover type except old fields and orchards, indicating their importance as a source for grouse food. Since the collections of grouse were not evenly distributed through the seasons, an ideal cross-section of the annual diet probably would show a lesser rating for such bulky foods as aspen, hazelnut, and willow.

Willow. Being numerous in lowland hardwoods throughout Maine, willow buds are easily accessible to the birds; together with a few leaves they furnished 16.3 per cent of the annual diet.

Hazelnut. Catkins and buds provided 11.3 per cent of the diet of grouse. Hazelnut is among the commonest shrubs, hence availability and usage seem parallel.

Apple. Fruits, buds, and leaves made 8.4 per cent of the food. Apple trees are comparatively scarce in lowland hardwoods, and nearby orchards probably were the major source of this food.

Clover. (*Trifolium*) The usage (6.3% of the total volume) in lowland hardwoods is more nearly in proportion to availability than in upland hardwoods; however, the amount eaten is still more than would be expected. The cover in which many of the birds were collected was broken by wood roads or close to old grown-up fields, and part of the clover presumably was obtained elsewhere than in the hardwoods.

Birch. These are among the most typical trees in this cover type, where catkins and buds made 3.9 per cent of the annual diet. The buds are not so large as those of aspen and willow, thus comparing unfavorably with those foods as to volume, even when taken in equal numbers.

Club-moss. Several species of *Lycopodium* are locally abundant as ground cover in this cover type, and in most of the others studied; they perhaps are of more importance for grouse than the present data indicate. The terminal sporophyl-bearing spikes furnished 3.6 per cent of the food in lowland hardwoods, chiefly in autumn.

Other foods. Wintergreen (3.4%), and chokeberry (3.3%) were also used as food to an appreciable extent.

OLD FIELDS AND ORCHARDS

Thirty-five crops were available for study in this cover type.

Apple. Apple trees are among the most common sources of food in

abandoned fields and orchards, their fruit and buds supplying a major portion of the diet. The fruit is eaten chiefly in autumn, and buds in late fall and winter. The combined volumes constituted 25.3 per cent of the food eaten in this cover type.

Hawthorn. This plant is more characteristic of old fields, hedgerows, and forest clearings than of woodland; its persistent fruit is a favorite food wherever present, and accounted for 24.2 per cent of the total taken in this type of cover. Similar findings were made by Kelso, by Kuhn, by Johnson (1928), and by Nelson, Clarke, and Bailey (1938).

Sumac. Both staghorn sumac (*Rhus typhina*) and smooth sumac (*R. glabra*) are common in old fields. The dry fruits persist into winter and are important for grouse at that season, furnishing 16.6 per cent of the diet.

Hazelnut. This shrub is less characteristic of old fields than sumac, raspberry, and blueberry; nevertheless, catkins and buds made practically 9 per cent of the food taken. The absence of raspberry and blueberry from important foods for this cover type is likely due to the limited number of grouse crops taken in summer.

Aspen. Although not so important here as in other types, aspen provided 7.2 per cent of the total food. Some may have been taken in other cover types bordering the fields, but the greater part undoubtedly was eaten where the birds were collected. *Populus* is common in old fields and orchards, being one of the first invaders in the reversion of cleared land to forest, and several birds were collected while "budding" in aspen trees.

Other Foods. Wild raisin (*Viburnum cassinoides*) accounted for 4 per cent of the diet in old fields and orchards, and wild cherry furnished 2.9 per cent.

Cover Types in Relation to Food

Comparison of cover type composition, representing availability, with the kinds of food eaten in the various types, reveals the highest correlation between availability and usage in old fields and orchards, which the grouse visit primarily to feed. The correlation is lowest where softwood trees predominate, the cover used largely for resting and shelter.

The method of obtaining cover type information did not yield data suitable for computing availability indices, or for calculating the correlation between availability and usage mathematically. The present study, however, points out one direction research must take before complete management practices can be formulated for ruffed grouse in any area, besides providing a practical basis for evaluation of grouse cover in Maine, pending detailed local investigations.

Summary

A total of 265 ruffed grouse were collected in Maine between October 1941 and September 1943, for analysis of food in the crops; 188 were collected in autumn, 47 in winter, 23 in spring, and 7 in summer. Items in each crop were measured volumetrically by water displacement, and data compiled by seasons and by cover types; relations between food availability and usage were studied for each type.

1. The correlation between food

availability and usage is highest in the old field and orchard type. This type offers considerable food, but a minimum of shelter at all seasons and is frequented by grouse primarily for feeding.

2. The correlation is lowest where softwoods predominate, a type of cover offering maximum shelter and used chiefly during adverse weather or for resting.

3. The principal foods taken in each cover type were as follows: (a) mixed growth types—aspen, hazelnut, clover, willow, and wild cherry; (b) upland hardwoods—aspen, clover, wintergreen, birch, and hazelnut; (c) lowland hardwoods—aspen, willow, hazelnut, apple, and clover; (d) old fields and orchards—apple, hawthorn, and sumac. Some foods apparently had been taken in types other than those in which the birds were collected.

4. Grouse in Maine subsist largely on catkins and buds in winter and early spring; on fruit, leaves, and insects in summer; and on leaves, fruit, catkins, and buds in autumn. Animal food is of significance only in summer.

5. Aspen is the most important single year-round food of ruffed grouse in Maine, being of first importance in winter and spring. The buds are eaten during these seasons, and in autumn the leaves are also of significance in the diet. The three other most important items, on an annual basis, are hazelnut, apple, and clover. Wintergreen occurs among the 10 most important foods for each season, except winter, when it ranks eleventh. There is high usage of hazelnut and clover in Maine by comparison with the results of investigations in other parts of ruffed grouse range.

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FUR RESOURCE MANAGEMENT IN BRITISH COLUMBIA

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The registered trap-line system[1] employed in British Columbia, Canada, for the past 19 years is one of the most effective trapping management practices used in North America. Regulations in the Game Act, covering the registration of trap-lines and granting exclusive trapping rights, were put into actual operation in 1926 and have been successfully operated, with few amendments, ever since.

The application of this system to trapping management in the United States might not be feasible because of the limited extent of our trapping territory. However, it is conceivable that some of the principles could be applied to the more extensive public land areas in the western states and Alaska.

Registering Trap-Lines

There are approximately 5,300 registered trap-lines in British Columbia of which about 3,000 belong to Indians. Women trappers are registered on about 5 per cent of the lines.

No limit is set as to the extent of trap-line which can be registered by any one trapper, but the Game Commission will not grant trapping rights for an area larger than it feels the trapper can reasonably handle. However, the objective of the regulations is to allow the trapper a lengthy line so that he may be in a better position to conserve the fur by trapping a portion in one year and then moving to another section the following year. Parts of the line are thus given a rest from year to year, which enables the furbearer population to build up.

Trap-line areas range in size from 10 to approximately 500 square miles. The Province is 366,000 square miles in extent, of which slightly over 90 per cent can be trapped. Between 50 and 60 per cent of this trapping area is allotted to whites. The Indian trappers, although in excess of the whites, have a somewhat smaller area to trap because of registrations by Indian bands.

Considerable difficulty was anticipated in registering lines at the start, particularly with regard to disputes between Indians and whites, but little was encountered. It is necessary to be a resident of the Province for six months prior to applying for a line. To register a line, the white or Indian trapper, or the Indian agent, submits a form application to the warden or constable in the district where the desired trapping territory is situated. This must include a complete description of the location and known natural or geographical features and, if possible, a sketch-map showing location of cabins, shelters, and trails. District officials then draw a sketch-map of the area and forward it to their Divisional Game Office, where it is mapped and sent to

[1] Province of British Columbia. 1942. Report of Provincial Game Commission. Victoria, B. C., Canada. P.M70. 1942. Regulations covering the registration of trap-lines or trapping areas. Game Act. Victoria, B. C., Canada.

headquarters. There again it is mapped, recorded, and if in order, finally accepted.

Trap-lines usually follow along rivers, streams or lakes, and the outer boundaries are the watershed divides. No registered line may approach within one mile of any other line. This one-mile boundary provides a safe breeding area through creation of a game reserve.

For certain tribes, it has been more satisfactory to allot a large bloc of territory to a particular Indian band, or bands. This is then divided among their trappers by the Indian agent. Generally speaking this policy has been followed, but some complaints have come from members of these bands with regard to other members encroaching on their particular territory.

Every trapper is required to submit another form application for renewal of his registration before September 30 each year. This license renewal costs $10.00, the same as the original license fee. The right to hunt in connection with the trapping is included.

REGULATION OF TAKE

There is no statutory limit to the take, but all trappers are warned that if they overtrap, their registrations are subject to cancellation.

The only real difficulty in regulating the take is with the illegal poaching of beaver. The Game Commission feels that the beaver is their most important fur resource because a favorable beaver population will promote, through water storage, the population of other fur bearers such as muskrat, mink, and otter. In the spring of 1945 the Provincial Legislature amended the Game Act by passing a regulation requiring the marking or tagging of all beaver pelts taken in the Province. It is felt that under this marking system the poaching of beaver will be eliminated because it will be impossible to sell an unmarked pelt within the Province. This would be similar to the system now successfully employed by some state game commissions and, on several of our Indian reservations, by the U.S. Fish and Wildlife Service in cooperation with the U.S. Indian Service.

Every registered trapper is required to submit an annual return form covering the fur taken. The Game Commission knows, over a period of years, what the take has been on each line and can, from the fluctuations in the annual take, generally determine whether there has been overtrapping. In this, plus the trapper's own interest in protecting and building up his line, lies the key to the success of the system. A fur census would be practically impossible due to the difficulty of censusing certain species, the large extent of territory to be covered, and the limited number of qualified men to make the count. Each trapper, however, is required to submit an estimate of the number of beaver colonies on his line. This is fairly reliable due to the comparative ease in making house counts.

In cases where the Commission feels that overtrapping has occurred, a patrol is made by the resident warden to obtain definite information on the overtrapping. In instances where it is decided that too much fur has been taken off, the trapper is given a warning that if the same thing happens another year his registration will be cancelled. Such warning usually is quite effective

and there have been very few cancellations.

Regulations require that the registered trapper personally make provision to carry on trapping within 15 days after the opening of the season. This protects his line by preventing poachers from moving into his territory before he starts trapping. The trapper may, under permission from the Game Commission, employ one licensed assistant to help him in his trapping operations.

A study of the annual take (Table 1) over the 16-year period since the system was put into effect shows it to have been comparatively uniform. There are yearly fluctuations, but these could result from intensive or light trapping due to prices, or to cycles in population. As a result of Canada's entry into the war in 1939, many lines went untrapped, or were turned over to other trappers whose take might have been different. With species such as fox, mink and muskrat, there has been an increase in the crop during the last four to six years as compared with a similar period at the beginning of the use of the system. This would certainly indicate a population build-up. In no case has there been an appreciable decrease in take which would indicate overtrapping over a long period.

TABLE 1.—ANNUAL TAKE OF FUR-BEARING ANIMALS IN BRITISH COLUMBIA AND ROYALTY COLLECTED, 1926–42.

Calendar year	Numbers and kinds of pelts on which royalty was collected									Total royalty collected
	Beaver	Fisher	Fox: silver, cross, red	Marten	Muskrat	Mink	Otter	Raccoon	Weasel	
1926	18,478	1,038	5,526	9,920	48,426	24,158	783	5,120	30,952	$56,056.13
1927	24,418	1,149	5,606	11,008	63,884	16,548	1,068	7,488	38,337	61,629.96
1928	20,662	887	2,514	11,610	65,130	11,968	981	7,141	46,782	51,563.07
1929	14,787	749	2,310	11,265	52,696	8,226	856	5,271	67,619	40,769.89
1930	17,137	681	1,330	9,172	84,500	8,995	838	3,790	52,630	40,431.11
1930	18,123	663	1,338	8,066	106,920	10,528	807	3,171	52,893	41,056.08
1932	12,624	558	2,144	8,750	100,509	12,977	662	3,555	48,357	36,253.79
1933	11,741	602	3,860	11,433	91,230	17,066	723	2,891	43,321	39,592.48
1934	10,826	709	5,550	9,747	127,111	21,408	770	2,419	43,666	42,697.81
1935	13,593	721	6,807	8,979	107,339	21,453	573	1,983	34,910	44,986.95
1936	14,269	760	7,737	10,071	91,591	20,362	754	2,856	36,307	46,186.50
1937	15,932	676	7,146	9,849	70,166	18,030	824	2,972	48,043	47,257.48
1938	15,291	502	4,528	8,461	76,516	20,146	596	2,278	44,159	39,423.87
1939	18,748	538	4,492	9,038	85,553	27,579	667	2,107	50,197	44,238.00
1940	20,652	558	4,110	9,678	117,506	37,986	749	1,798	71,580	62,745.33
1941	21,107	585	3,614	9,200	116,722	20,675	706	2,648	32,949	56,755.30
1942	18,266	1,289	4,881	8,351	89,759	43,424	485	2,125	57,299	63,176.07
Totals	286,654	12,665	81,580	174,598	1,495,558	341,529	12,842	59,613	790,001	$814,808.92

FUR VALUATION

A conservative estimate of the value to the trappers of the average annual take of furs is $1,750,000. The Province collects a royalty (Table 1) on each pelt when sold by the fur dealer, these being: squirrel, $0.02; muskrat, $0.10; mink, $0.50; beaver and marten, $1.50; fisher $2.00; etc.

The average annual income per trapper is difficult to determine because of the differences in trapping territories, in the abilities of various trappers, and in the length of time each spends at the work. A skillful trapper, working full time for six months, would average about $3,000 and an average trapper in the upper brackets probably $2,000.

The author talked to two fur dealers in different districts of the Province, and both were of the opinion that the annual income for most trappers would be about $1,000. One trapper, whose line ran along 147.5 miles of stream, realized $10,000 in 1942–43. His main fur resource was beaver and in that year 189 pelts were sold at an average of $50 each. During the five-year period, 1939–44, he caught 103, 50, 108, 189, and 144 beaver, respectively, besides small catches of mink, muskrat, weasel, marten, bear, lynx, and fox. The higher beaver population resulted from the trapper having developed dried-out natural or artificially-built water holes which had been used by cattle in grazing.

DISPOSAL OF TRAP-LINES

Regulations prohibit the leasing or loaning of a trap-line to another trapper without permission from the Game Commission. Considerable trouble has resulted from this practice through overtrapping, with the result that few permissions are granted. If a trapper fails to work his line for a period of years, he usually must forfeit his rights. The Commission feels that the line should be protected by the trapper actually being on the area, or else should be allocated to someone else who will operate the line. This does not apply to men who had to leave their lines because of entry into the armed services.

Trap-lines can be sold, but the sale must be approved by the Game Commission. A careful investigation is made prior to a sale to determine whether the trapper has taken off too much fur. This is to prevent a trapper from buying a line, trapping it closely, then selling it and buying another. The Commission does not regulate the price for which trap-lines can be sold. This is an individual matter between the trappers. On one occasion a registered line on the Finley River was sold by the administrator of an estate for $2,500.

If public land is purchased by an individual, the trapping rights on the area revert to the new owner. However, in order to protect the trapper, who may have been building up the fur resources on the area prior to the sale, the regulations provide that he shall have the trapping right for two years after the sale. The Land Department cooperates closely with the Game Commission to prevent a person from buying land after someone else has built up the fur population. In many cases the registered trapper will be given the first right to purchase the land.

EFFECT OF THE SYSTEM

Since the regulations have been in effect, the trappers have more or less become fur farmers. The majority have a genuine desire to protect and build up their fur population, and to crop off only the surplus. Prior to the regulations, a trapper had no assurance that he would have the same line from year to year and consequently he trapped an area as heavily as possible. The registered trap-line system largely eliminates the possibilities of any species becoming seriously overtrapped, and favors a uniform annual take.

The author talked to 67 trappers, fur dealers, game wardens, and other Game Department officials and all were of the opinion that the system is a good one. A disadvantage is that not every-

one who might want to trap is able to do so because most trapping territory is now under registriation. This is partly overcome, however, through the possibility of leasing or purchasing a line.

SUMMARY

The registered trap-line system employed in British Columbia during the past 19 years is an excellent fur resource management practice, but requires an extensive territory.

There are approximately 5,300 registered lines in the Province, varying from about 10 to 500 square miles in extent. Large areas allow for a portion to be trapped one year while another rests.

Trap-lines usually follow streams or lakes with watersheds as outer boundaries. There is a one-mile reserve between boundaries of adjacent lines.

Every trapper submits a return form. There is no prescribed limit to the take, but overtrapping may result in cancellation of the permit. Overtrapping is indicated by fluctuations in annual takes, and confirmed through investigation of the area by a warden.

Poaching of beaver has occurred, but can be reduced considerably through a recent regulation requiring that all beaver pelts be officially marked or tagged before they can be sold.

Annual returns indicate a marked increase in populations of fox, mink and muskrat, during the last 4 to 6 years, over that for a similar period at the start of the system in 1926.

Annual average income for trappers in upper brackets ranges from $2,000 to $3,000 for 6 months of work, with $1,000 as a possible average for all. As much as $10,000 has been made in one year by a single trapper without detriment to the breeding population.

Lines can be leased, loaned, or sold, but authority must be granted by the Game Commission.

The system appears to be universally favored. Registered trappers have, to a certain degree, become fur farmers, and the majority desire to protect and build up their fur populations, and to crop off only the surplus.

HABITS OF COYOTES IN DESTROYING NESTS AND EGGS OF WATERFOWL

Clarence A. Sooter

Tule Lake National Wildlife Refuge, Tule Lake, California

Studies on waterfowl and methods for increasing their productivity during recent years have placed much emphasis on the factor of predation. Consequently, the interpretation of various predator "sign" and collection of data at nests found destroyed is of interest. The similarity of damage to nests and eggs by various predators and the obscure nature of the evidence confuses the investigator at times to where the damage cannot be definitely assigned. Unless the evidence is conclusive, it is only fair to list such damage as caused by an unknown predator. In other instances identification of the animal

responsible becomes possible by evidence left at the nest. This paper describes the general pattern of "sign" to be expected at a duck or goose nest when destroyed by a coyote.

That portion of the Great Basin occupied by the waterfowl areas of the Malheur National Wildlife Refuge, Harney County, Oregon—the Donner and Blitzen River Valley and the vicinity of Malheur Lake—is surrounded by sage brush and grassland range. In dry years and those of low rodent populations, these environs offer little attractive hunting for coyotes. At such times these animals tend to drift into the waterfowl nesting habitats provided by the Refuge. Pressure on nesting fowl and their young can be expected from coyotes even during normal years on the surrounding range, as a moderate number of these animals always frequent the Refuge.

The writer observed the types of nest and egg destruction by the coyote (*Canis latrans lestes*) during the seasons of 1938 to 1943. The coyote proved to be a major predator affecting waterfowl production on the Refuge, being equaled only by the raven (*Corvus corax*). Predation was studied in connection with work on waterfowl in which histories were completed on 2,074 nests of ducks, geese, and cranes. Most of the record on predation is from nests found destroyed during 1938. Other than some dummy nests, no nests were watched especially for coyote damage. Several nests destroyed by mammalian predators had so little definite sign that they were listed as due to an unknown predator. Damage was recorded as definitely the work of a coyote only when there were fairly plain coyote tracks nearby, or the eggs were buried in the manner used by a dog. When eggs had been removed without leaving shell remnants, or damage to the nest left little or no sign, it was difficult to determine whether a bird, mammal, or snake was responsible. The location of the nest helped to solve the question in some instances. A snake or coyote would scarcely visit a nest on a small island in densely matted vegetation, or on a muskrat lodge surrounded by a moderate expanse of deep water. Comparison of damage at such sites and those

TABLE 1.—WATERFOWL NESTS AND THOSE DESTROYED BY PREDATORS, MALHEUR NATIONAL WILDLIFE REFUGE, 1938–43.

	Nests			
	Duck	Goose	Crane	Totals
Nests under observation	1284[a]	1417	80	2781
Fate determined on	1020	978	76	2074
Predator				
Ravens	16	89	9	114
Birds[b]	27	24	2	53
Coyotes	21	30	2	53
Coyote Type	40	9	1	50
				270

[a] Three seasons detailed study.
[b] Most probable predator was raven.

where the evidence as to predation was more complex was of value. Observations on ravens feeding at waterfowl nests, and definite coyote signs at destroyed nests, aided in interpretation of the sign found. In the more difficult situations it was helpful to know the relative abilities of a coyote, skunk, or raccoon to clean out an egg shell more than a bird and not leave sharp edges all around the shell punctures (Pl. 2).

HISTORY OF NESTS

To illustrate the kinds of "sign" to be expected, typical records are given of destroyed nests near which definite coyote signs were noted.

Nest no. 426. Mallard, 11 eggs and small amount of down, June 1, 1938. On bank of an irrigation canal excellently concealed in dense stand of wild mustard. Coyotes and their tracks previously noted in the vicinity. June 9: four eggs destroyed, seven undisturbed; evidently deserted. Each destroyed egg broken on one side in the manner used by a mammal and contents eaten; shells still in nest. Fairly plain coyote track at nest and faint tracks leading to it. Passage way through vegetation to the nest opened up by an animal of a coyote size; nest down and other material not disturbed. June 26: nest undisturbed, seven eggs remained, but their contents by then of doubtful interest to a coyote.

Nest no. 446. Mallard, June 2, 9 eggs and abundant supply of down, excellently concealed in large clump of greasewood. June 11: clutch completely destroyed; moderate rain a few days previously and plain coyote tracks in mud about nest but no other animal tracks or sign. Eggs had been eaten in a line across the front of the nest (Pl. 1, B) but shells more than 5 yards from nest. None eaten in the nest cavity, as no shell remnants found there. Each egg broken in on one side and contents evidently lapped out, as interior of shell was clean. Nest down not noticeably disturbed.

Nest no. 425. Gadwall, 10 eggs and moderate amount of down, June 1, poorly concealed in shallow cavity in open meadow, mainly of short and fairly dense brome grass. Soil about nest loose peaty, would show tracks fairly well. Coyote tracks previously noted in general vicinity. June 9: clutch destroyed, coyote tracks around and leading to nest and shells, down of nest partly pawed from one side. Eggs broken open in mammal-fashion, all but one shell in the nest, and that a short distance to one side.

Nest A. Presumably gadwall, 8 eggs and scant supply of down, June 17. At base of small ill-formed clump of sagebrush, about 75 yards from a coyote trap (where several coyotes taken) placed in trail passing within 8 yards of nest. June 26: nest destroyed, several plain coyote tracks to and from nest and to empty egg shells. No other mammal or bird tracks nearby. Shells and down scattered in radius of 5 to 6 yards of nest. Damage to egg shells typically mammalian, apparently widely spaced tooth marks on one shell.

Nest no. 525. Duck (species unknown), 12 eggs and moderate amount of down, June 16, well concealed in medium-sized clump of greasewood surrounded by light stand of salt grass. Soil around nest fairly soft and moist, any coyote tracks would show plainly. June 30: nest completely destroyed.

Remains of 10 eggs scattered in fairly straight line across front of nest within 6-yard radius. Two eggs not accounted for in remnants present, may have been completely eaten by coyote. Down scratched from nest and scattered in a dog-like manner. Two fairly plain coyote tracks near the front of nest, another near where contents of one egg had been eaten, and wide-set tooth prints on two well crushed shells.

BURIAL OF EGGS

Nest no. 513. Gadwall, 12 eggs and fairly heavy supply of down, June 15. Excellently concealed in dense clump of giant rye grass and greasewood on island surrounded by water of sufficient depth to make a coyote swim a short distance. June 29: no eggs or shell remnants in nest cavity; 4 eggs buried in a dog-like manner within 5 yards, later partly exposed by light rain which evidently washed away any tracks. One egg broken, contained well developed embryo. No evidence of missing eggs. In burying, a shallow cavity had been scratched in the earth and after placing an egg the dirt and debris evidently had been nosed over it.

Nest no. 572. Mallard, 8 eggs and sparse amount of down, June 28, poorly concealed. On island about 15 by 30 yards, with moderate cover of rye grass and wild rose. A coyote would have to swim in reaching the island. July 7: only 2 eggs partly covered in nest. One missing egg 6 yards south of the nest and two 6 yards west; one of latter pecked open at end by a bird and most of contents eaten. A fourth egg just north of the nest, partly buried in a dog-like manner as in nest no. 513. No trace of other 2 eggs. Down in nest had not been noticeably disturbed. The 2 eggs in the nest partly covered with nest material and it was surmised that the incubating bird was absent when nest was located by predator.

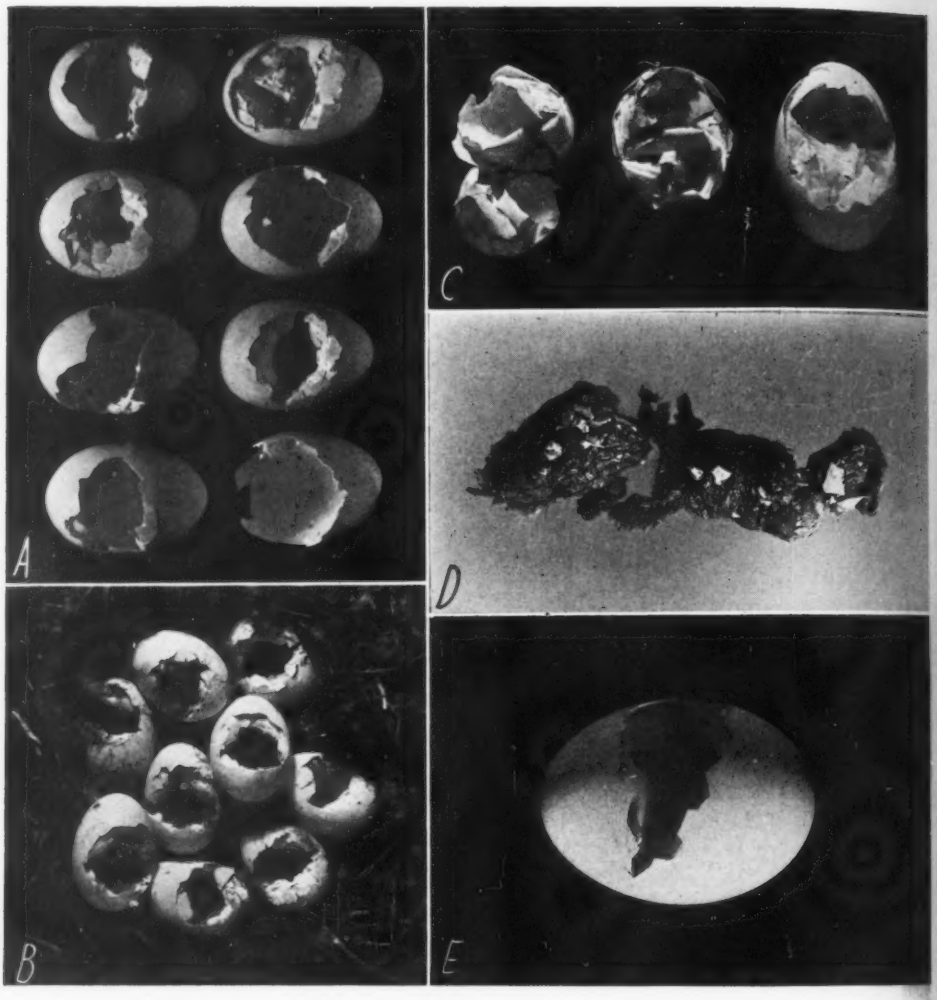
Duck nest. Emptied when found, June 29. Fairly well concealed on an island about 200 yards southwest of that holding nest no. 513. One egg buried dog-fashion, covered only with debris and a little dirt, at the base of greasewood clump about 4 feet from nest (Pl. 1, C). No other eggs, shells, or tracks in immediate surroundings. Down scratched out of nest. Evidently the work of a coyote, as no dogs ever present in the vicinity.

Canada goose nest. Recently destroyed when found, April 10, 1942. On island in Boca Lake, separated from mainland by a narrow water channel. Soil under and around nest of soft peat, with low mudflat nearby. Nest poorly concealed; moderate amount of down present, was scratched out and scattered about. One cleaned egg shell 6 yards from nest, with coyote tracks around it. Another egg buried dog-fashion under peat in small hole, about 10 yards from nest. Coyote tracks near buried egg and on other parts of island. Estimated 4 eggs in clutch, from egg material found. The writer chased coyotes from the island on previous occasions.

SHELLS IN COYOTE DROPPINGS

Coyotes ingest some of the shell when eating waterfowl eggs, as evidenced by examination of their droppings during the nest season (Pl. 2, D). Sixteen of 44 (36%) droppings in 1942, and 17 of 37 (46%) in 1943 contained egg shell. This gives a rough figure on the propor-

Coyote damage to duck nests, Malheur National Wildlife Refuge, Oregon, 1938. *A*. Destroyed nest with shells in front; pocket knife placed at nearby coyote track. *B*. Nest no. 446, mallard. Lath points to next site, egg shells scattered in front. *C*. Egg found buried near unidentified duck nest. *D*. Egg shells from coyote feeding experiment at Bear River Refuge, 1940.



Coyote damage to duck nests, Malheur National Wildlife Refuge, Oregon, 1938. *A.* Eggs from nest "a" destroyed by coyote. *B.* Nest no. 496, gadwall, destroyed by mammal; work like that of coyote. *C.* Nest no. 525, shells remaining after destruction by coyote. *D.* Coyote droppings showing fragments of egg shells. *E.* Egg of ruddy duck destroyed by raven.

Eggs
k like
drop-

tion of coyotes taking eggs, but little of the actual number of nests destroyed. O. J. Murie (Journ. Mammalogy, 26: 33–44, 1945) mentioned only one occurrence of duck eggs in 664 coyote scats examined from Montana and British Columbia. Adolph Murie (Fauna of the National Parks of the U. S., Bul. 4, 1940) reported bird remains in about 5 per cent of 5,086 coyote scats, but duck eggs were not mentioned.

PENNED COYOTES AND EGGS

To learn the number of eggs a hungry coyote would take, its manner of handling the eggs, and the exact condition in which shell remnants would be left, C. S. Williams experimented with a pair of captive coyotes at the Bear River Migratory Bird Refuge, Brigham, Utah, for the writer.

A male and female were kept without food for two days (January 13–14, 1940); at 10:00 a.m. on the third day (January 15), 36 chicken eggs were placed on the floor of the cage. Seven minutes passed before any were taken, due mainly to human activity near the cage. Subsequent events were as follows.

At 10:07 the male eagerly picked up one egg, held it in his mouth and circled the cage for 2 minutes, then broke it by biting. The entire egg then was dropped to the ground and the yolk and albumen lapped up. The shell was smashed almost completely and some fragments must have been eaten with the contents. Meanwhile the female nosed the eggs but made no attempt to take any until 10:12, when she took one but seemed unable to break it. The egg was dropped several times before finally breaking in her mouth. Again it was dropped, and she lapped up the contents. By 10:15 the male had consumed 13 eggs and the female had taken two. The male then was slowing perceptibly and required 50 seconds to take and eat the next egg. By 10:19 he was apparently full and licking old shells on the ground rather than breaking new ones. It was 10:26 before he took another entire egg. By 10:36 he had eaten 3 more, for a total of 20 eggs. During the next 30 minutes he divided his activities: he broke 3 eggs which the female ate, buried 2 more (one of which the female dug up and ate), lapped old shells, and consumed 2 more eggs himself. The female continued to have difficulty in breaking eggs, and spent much time nosing them around. By the end of the first hour, she had consumed 12 eggs and the male 22. The two coyotes had taken 34 of the 36 eggs available.

At the end of the hour (11:00 A.M.) the remains of eggs in the cage were removed and 36 more entire eggs made available to the coyotes. By 1:13 P.M. there were 29 eggs left, 2 of which had been cracked but not eaten. At 6:00 P.M. 25 whole eggs remained, the 2 cracked ones and 2 others had been eaten.

The further record of the egg feeding experiment may be summarized as follows:

January 16. At 8:00 A.M., 10 eggs remained; these were frozen. They were replaced by 36 fresh eggs. By 1:00 P.M., 14 had been taken, by 2:00 P.M., 2 more were gone, and by 5:00 P.M., 21 in all had been eaten.

January 17. At 8:30 A.M., no eggs remained. Up to this time the 2

coyotes had consumed 96 eggs; then 36 more were placed in the cage. By 11:00 A.M., 19 of them had been consumed.

January 18. At 8:00 A.M., all eggs were gone. At 10:00 A.M., 36 more were placed in the cage, and also a rabbit. The coyotes paid no attention to the eggs, trampling some while tearing the rabbit to pieces. By 10:15 A.M., 4 eggs had been eaten; 2 more rabbits were introduced. By noon one rabbit had been eaten but the other was untouched. Four eggs had been eaten and 9 trampled. At 1:00 P.M., one rabbit remained untouched. Seven eggs were untouched, 13 more (22 in all) trampled and 3 had been eaten. The female was restless and regurgitated rabbit meat; 3 more eggs trampled. Then 24 additional eggs were placed in the cage. At 5:30 P.M., the rabbit was gone, one egg had been eaten, and 27 eggs remained.

January 19. At 8:30 P.M., 25 eggs remained, only 2 had been eaten.

There was wide variation in the pattern of egg breakage, hence egg predation by coyotes would be difficult to identify. In fact, had the coyotes not been watched while cracking the eggs, some of the work would have been thought to be that of birds if the eggs had been picked up in the field (Pl. 2, A).

The male was skillful at breaking eggs, and could do so by forcing them against the roof of his mouth, without resorting to tooth pressure. The female left tooth marks on some eggs that she broke, but she was not adept at the process. A fair idea of the number of eggs an average coyote might take would be obtained by halving the egg consumption in this experiment as the two coyotes evidently were near the extremes in this habit.

SUMMARY

Destruction of waterfowl nests and eggs by coyotes on the Malheur National Wildlife Refuge varies as to pattern. At times it is difficult to distinguish damage by coyotes to eggs from that done by birds. At times coyotes bury eggs taken from nests they have located.

VARIATION IN PATTERN OF PRIMENESS OF MUSKRAT SKINS

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Muskrat skins are "cased" flesh side out. Raw fur dealers readily determine the degree of primeness by glancing at the dorsal (back) and ventral (belly) sides. The extent of the pigmented area together with the intensity of the pigmentation are primary factors in such determination. Most fur dealers, however, do not know the causes of these appearances or the story that their pattern unfolds. This, however, has been reported scientifically by several investigators. The darker areas are the result of an accumulation of

pigment in the roots of the new hairs deep-seated in the dermis. As the hair fiber grows the store of pigment is lessened, the root itself tends to migrate towards the surface, and the fiber assumes a less acute angle to the surface of the skin. The trend towards full growth of the fur is inverse to the degree of pigmentation seen on the flesh side of the skin.

It is generally believed that the sequence of this priming is, in broad terms, from the ventral side progressively toward the dorsal area which primes up last. In the course of some research studies on the marketing of furs from the National Wildlife Refuges a casual observation of several hundred skins revealed that possibly such a simple procedure of priming does not portray the complete picture.

The various designs of pigment distribution seen on the flesh side of the raw muskrat skins were noted and were classified into the 12 general types listed in Table 1. A group of 415 muskrat skins, from Horicon Refuge (Wisconsin), Tule Lake Refuge (California), and Delta Refuge (Louisiana), that had been graded by the auction companies as to size, and as "fall" and "winter" without regard to pattern of primeness, were classified in accordance with the above 12 types. All skins had been taken during November or December. Both the dorsal and the ventral sides were considered in the recording so that a sequence of priming might be synthesized. In Table 1, the descriptive headings for the six central columns (columns 4 to 9) do not necessarily indicate degree of primeness from left to right; they are really descriptions of types of priming pattern rather than a sequence. A group of skins having a similar pattern on the dorsal view were assigned a letter of the alphabet at random (a symbol would have been just as satisfactory) and this letter was recorded as many times in the appropriate column as there were skins of this pattern. The same letter was then inserted in the column or columns describing the ventral pattern or patterns. The dorsal and the ventral descriptions of each skin are thus readily available.

For example, of the 13 XXXL autumn skins from the northern muskrats, 2 on the dorsal side were "unprime except for small spots" and were designated by "dd" in the proper line and column. The ventral surface of these 2 skins, having the same general appearance as the backs, were designated by "dd" just beneath the dorsal description. There were 6 of these 13 skins that had a dorsal description of "unprime except large spots" and each has been identified in the appropriate column by the small letter "a." The ventral side of these same 6 skins, however, showed four different patterns: 1 "unprime except large spots," 1 "unprime narrow sides," 3 "prime except large broken areas or spots," and 1 "prime." A distribution of the letter "a" was made in the respective columns. The particular letter used with each size group has no significance whatever as to that same letter in another size group.

It should be kept in mind, of course, that intergrades of the above patterns existed and had to be assigned in the judgement of the appraiser to the group most nearly representative. The length of the line of the letters will indicate

TABLE 1.—DESCRIPTIONS OF PRIMENESS IN MUSKRAT SKINS GRADED BY FUR AUCTION COMPANIES.

		Number of skins	Size[b]	Surface	Entirely unprime	Unprime except		Unprime						Prime except		Prime
						Small spots	Large spots	Wide center and sides	Wide sides	Wide center	Narrow center and sides	Narrow sides	Narrow middle sides	Large broken areas or spots	Small broken areas or spots	
TULE LAKE AND HORICON REFUGES, NOVEMBER AND DECEMBER, 1944	FALL	13	XXXL	Dorsal Ventral	g	dd dd	aaaaaa a		g	f		a		bb baaal	c cb	a
		13	XXL	Dorsal Ventral		dbbaa	a	bbb	ddd b	aaaaaa		d		c ca	daa	
		12	XL	Dorsal Ventral		acc	dd	cccc	ddd	aaa	h			b b	daacch	
		17	L	Dorsal Ventral		f aaaf	aaaaaaaac	aaaaaaaaaaa	h c	cccc c				a	hc	
		17	L-M	Dorsal Ventral	h	a ddgg	ccch		gg c	bbbbbb	ccccc	dd			abbbbb	bc
		18	M	Dorsal Ventral	ee	aaaa db	adee	ff	bb b	cccccc	dd			f	acfcccc	aa
		8	S	Dorsal Ventral	d	aaabe			aaaa	bb b	d	e		a		
		20[a]	S	Dorsal Ventral		aa bbb			bbb dd	ccccccccccc	dd		e	ccc	cccccccc	aae
	WINTER	25	XXXL	Dorsal Ventral										bbbbbbb aaaaaabbbb	aaaaaaaaaaaaaaaa aaaaaaaabbbaaa	a
		27	XXL	Dorsal Ventral		ad	d				aa	bb	cccccccc	ddddddddd dddeedd	cccc abbccccde	ccccdde
		26	XL	Dorsal Ventral		aac	b	aaaaa	bb	ccc	f		ddddddddddddddd	aaddd	abcddddddddfdddd	
		22	L	Dorsal Ventral			aadd		aa	bb			ccccccccccccc	ddd ccc	bccedcccccccc	b
		20	L-M	Dorsal Ventral		aabdd	abb	aaa	dd	bbbbbbb			cccccc	b	f bbccccccef	b
		20	M	Dorsal Ventral		bbbbbbb	a			aaa		bbbbbbb	ccccccccc	c	aaccccccccc	
		10	S	Dorsal Ventral		b	b			aa		bbbb ab	cccc	b	ac	ccc
		20[a]	S	Dorsal Ventral		bb ccc			ccc dd	aaaaaaaaaaaa	dd		e	aaa	aaaaaaaaa	bbe

TABLE 1.—*Continued*

		Number of skins	Size[b]	Surface	Entirely unprime	Unprime except		Unprime						Prime except		Prime
						Small spots	Large spots	Wide center and sides	Wide sides	Wide center	Narrow center and sides	Narrow sides	Narrow middle sides	Large broken areas or spots	Small broken areas or spots	
DELTA REFUGE, LOUISIANA, DECEMBER 1944	FALL	10	XXXL	Dorsal Ventral		aaaa	aaaa							bbbbbb	bbbbbb	
		10	XXL	Dorsal Ventral		aa b	aabbbb						bbbbbbbb			bbb
		10	XL	Dorsal Ventral	aa		aa	aaaa					bbb	ccc ccc		bbb
		10	L	Dorsal Ventral	a		aaaac	aaaaaa		bb	cc			bc		ab
		10	M	Dorsal Ventral		aa	aab	aaaaaa		bbbb				a	ab	bb
		16	S	Dorsal Ventral		bbbbbb	aaa	aaaaa	bbbbbb	ccccc				aa	ccc	cc
		15	XS	Dorsal Ventral		aabbbbb		aa	bbbbb	ccccccc					ccccc	ccc
	WINTER	10	XXXL	Dorsal Ventral										aaaaaa	aaaaaa bbbb	bbbb
		10	XXL	Dorsal Ventral										aa	aaaaaaa aaa	bbb aabbb
		10	XL	Dorsal Ventral							a		bbbb	ccc bc		dd abbbccdd
		10	L	Dorsal Ventral			a			a			bbbbbb	c c	bbbbbbd	dd d
		10	M	Dorsal Ventral		a	bbb	aaa	a				bbbb	cc	d abcod	
		4	S	Dorsal Ventral			a						aaa	b aa	b	
		5	XS	Dorsal Ventral		aa			aaa			bb			a	bb

[a] Unclassified as to winter and summer; same 20 skins as listed elsewhere in table.
[b] Size (graders standards) XXXL, largest; XXL–XL, next largest; L, large; M, medium; S, small.

graphically (within certain limitations) the relative prevalence of certain patterns for each auction grade represented. The graphic picture would have been much more effective if the number of skins for each grade had been large and identical.

All except two of the pattern-types listed in the table are represented in either the dorsal or the ventral view or in both views of the skins as shown on Plate 3, A-I, which are photographs of pencil drawings. Photographs of the skins themselves were not satisfactory because the blood, photographing dark, tended to mask the pigment of the hair roots. The areas that had already become completely prime during the current season are unshaded and those approaching primeness are lightly shaded. The darkest areas are those most unprime.

A study of the table and plate reveals that muskrat skins may start priming up on the ventral side (Pl. 3, B, H) on the dorsal side (Pl. 3, E), or, below the mid-dorsal area (Pl. 3, F. G). A combination of these general patterns may also occur at the same time. The extremities tend to prime first. Of interest is the extremely large percentage of the XXXL, and XXL skins that show only the broken areas or spotting pattern (Pl. 3, I) of priming. Can it be that such is the prevailing pattern for the animals taken during the second or subsequent years of life?

LIVE TRAPPING AND TAGGING MUSKRATS

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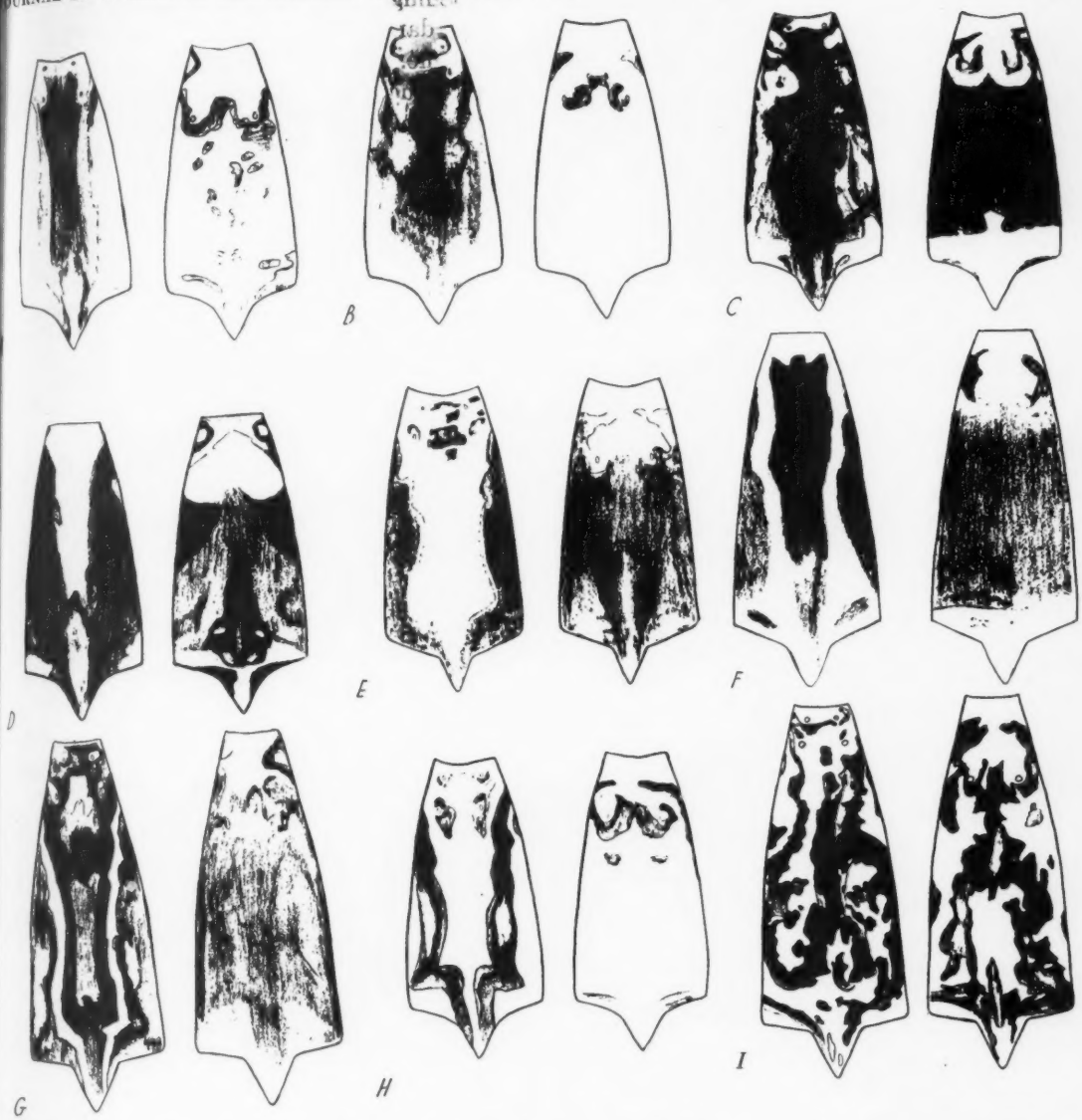
The findings from a study of winter trapping of muskrats on the Sand Lake National Wildlife Refuge, South Dakota, in the winter of 1943–44 suggested the need for information on movements of the animals during the winter. To accomplish this, 367 were live-trapped, ear-tagged, and released in the summer of 1944. Errington and Errington (1937) stated that "the muskrat even as an adult does not have a large enough external ear to allow the fastening of ear tags of the sizes conveniently available . . . " so they inserted the tag through the skin of the back between the shoulder blades. Cook (1941) encircled the tendon of Achilles with a metal band, and Takos (1943) tried a band around the hind leg above the heel joint. All these methods have certain objectional features, such as injury to legs, chances of infection, damage to the pelt, and considerable work in attaching the tags.

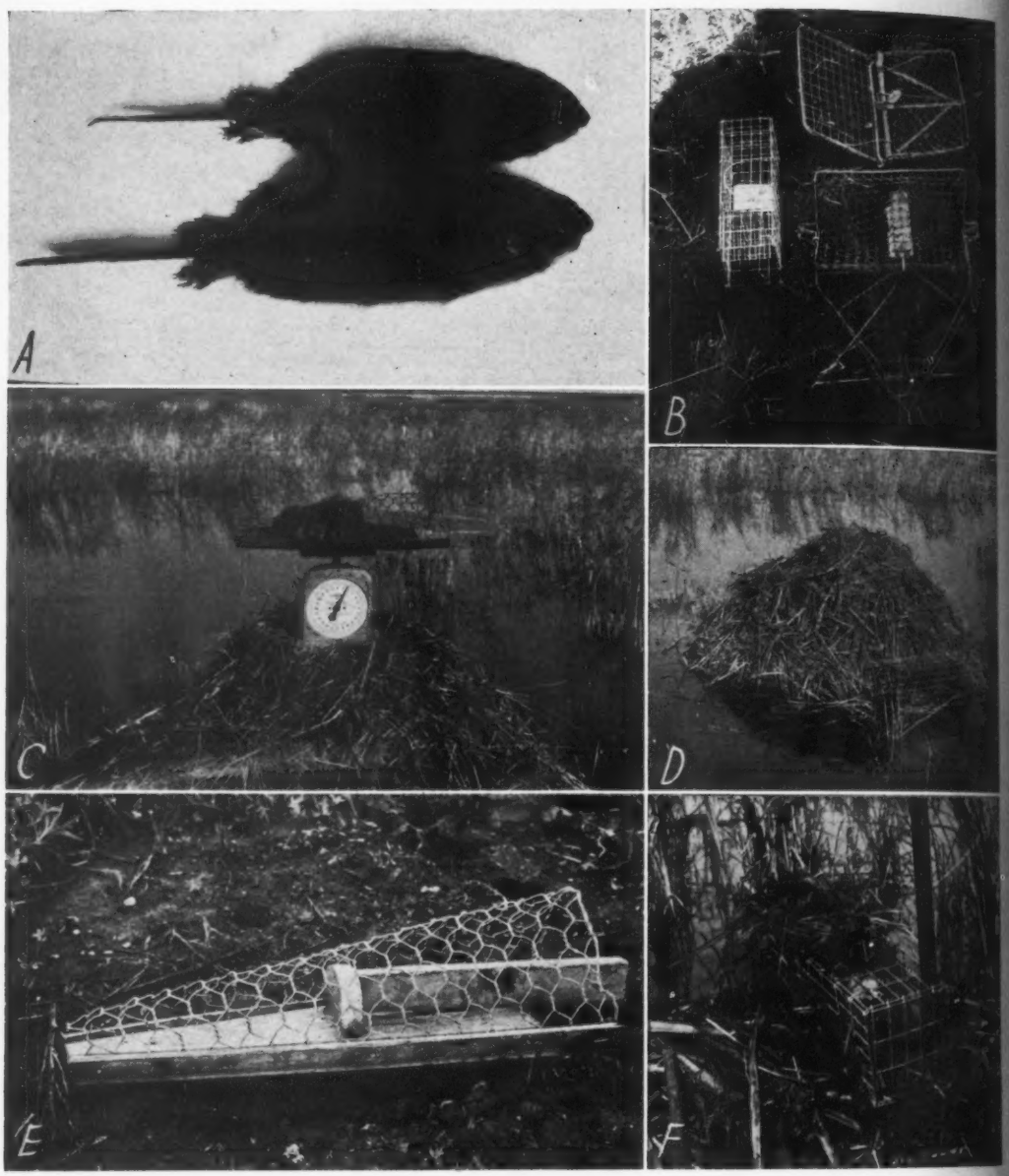
The ear tag used by the author is a monel metal fingerling tag 2×7 mm., having a 2 mm. space separation for the thickness of the ear. This was applied to the external ear to the full depth of the tag. The hair extending from the end of the ear was usually clipped to facilitate proper placing of the tag.

The ear proved to be amply large to accommodate such a tag, even on muskrats weighing as little as four ounces. The chances of the tags remaining in place are very good, as shown by



Pencil drawings of muskrat skins showing degrees of primeness (darkest areas are most unprime). Dorsal view at left and ventral at right in each pair of figures. All skins from Tule Lake National Wildlife Refuge California, except "G" which is from Delta Refuge, Louisiana.

A. Medium, winter. *B*. Medium, fall. *C*. Medium, fall.
D. Medium, fall. *E*. Small, fall. *F*. Large, fall.
G. Extra large, fall. *H*. Medium, winter. *I*. Extra large, fall.



Live trapping and tagging muskrats. *A*. Two muskrats with ear tags in place after 3 and 3½ months. *B*. The three types of live traps used: National (left), Hancock (top), and Gibbs (bottom). *C*. Muskrat in cone holder being weighed in field. *D*. National trap as set on side of muskrat house. *E*. Special cone for holding muskrats while being examined, weighed, and ear-tagged. *F*. Occupied trap; the muskrat has pulled nest material into the trap, and muskrats outside have partly covered the latter.

recaptures, and by the fact that a three-pound dead animal could be suspended in the air by the tag without tearing the ear. In nearly 100 returns after several months not one instance of tearing or irritation was detected. Plate 4, A shows two muskrats with ear tags in place after several months.

Three types of live traps were tried—the Gibbs, Hancock, and National—but for all purposes the National (Pl. 4, B) proved most successful and produced fewer injuries to the animals. It had an added advantage of being light in weight and collapsible so that large numbers of traps could be transported with minimum effort.

Trapping extended from July 15 to October 14, 1944, a majority of the muskrats being caught from August 20 to September 16, when one man gave full time to the work. During the early part of the period trapping was confined to the banks and dikes, as practically all muskrats had left the marsh and were living in bank dens. The favorite trap location was in runways through vegetation close to the water line. Apples, carrots and cantaloupe were used as bait; apples proved the best attractant. Cantaloupe was satisfactory, but both apples and cantaloupe were difficult to obtain and carrots were used mainly, with satisfactory results.

As the animals began to construct houses in the marsh, the traps were moved to those sites. Sets could be made almost any place on the house but the runway up the side seemed the best and most logical location (Pl. 4, D). Any trap set on the top of a house extending four feet above the water line usually was occupied by a muskrat the next morning. After being caught, an animal would attempt to conceal itself by pulling vegetation through the wire of the trap until there was only a small spherical nest space inside the vegetation which otherwise completely filled the trap. Often a trap would be covered over by the activities of other muskrats. These mannerisms made it possible to trap later in the autumn than ordinarily expected, as the animals seemed to be very snug in their trap nests (Pl. 4, F). When trapping on houses it was necessary to stake the trap so that it could not be tipped into the water; a few animals were drowned when this precaution was not taken.

The first few muskrats tagged were grasped by the back of the neck, but it proved difficult to apply the tag with only one hand free, and the tight grip necessary usually choked the animal. A cone-like holder therefore was developed and proved very satisfactory (Pl. 4, E). An animal is helpless while in the cone, but cannot be injured or injure the operator. Having both hands free, the operator can readily apply the tag, and determine accurately the sex and weight of the animal.

The cone can be made readily from available scrap materials. It consists of a V-shaped piece of one-inch board, 18 inches long, 1½ inches wide at one end and 8 inches at the other. Over this is nailed 1-inch "galvanized-after" poultry netting wire one inch above the tip of the board and 5 inches at the wider end. The wire extends only 15 inches along the board, leaving a section of smooth board down which to slide the animal into the cone. This prevents the animal from grabbing the wire while being inserted head first into the cone.

The most satisfactory procedure is to grasp the animal by the tail, pull it out of the trap, dangle its head over the cone (held in the other hand), and quickly thrust the muskrat into the cone. Being unable to back up or turn, the animal will rush forward in an attempt to escape and wedge itself tightly in the small end of the cone. There it can be held by a gentle pressure with one hand while the plunger stick is inserted behind. The stick can be either tied in place or held against the operators body while the tag is applied. While in the cone the animal can be sexed, using the method of Dozier (1942), and then be weighed (Pl. 4, C). The animal can be removed by pulling gently on its tail; or if tipped up and the tail allowed to dangle in water the muskrat usually will drop out. If left undisturbed on the house or bank for a few minutes, the animal usually will back out of the cone of its own accord.

In all, 367 muskrats were ear-tagged and released; of these, 251 entered the traps once; 80 returned for a second capture (of which 8 died in the traps); 24 returned for a third capture (4 died); eight returned a fourth time; and four returned for a fifth recapture (3 died). This made a total of 352 tagged animals (less natural mortality) from which winter trapping returns can be obtained.

Thus the fingerling tag can be applied successfully to the ears of muskrats, even those weighing only 4 ounces. This method is easier to use and lacks the undesirable features of older methods. Use of a cone-like holding cage permits the animals to be handled without injury and both hands of the operator are free to apply the tag and to examine sex and weigh the animal.

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INCIDENCE AND TRANSMISSION OF *SARCOCYSTIS* IN COTTONTAILS[1]

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The muscle-dwelling protozoan parasite, *Sarcocystis*, was first noted in rabbits by Manz (1867) in Germany. Brumpt (1913) named the species *Sarcocystis cuniculi* from the European hare but gave no description. A

[1] Paper No. 2241 Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul. Division of Entomology and Economic Zoology, University of Minnesota, and Pittman-Robertson Project 11-R, Minnesota Division of Game and Fish, Department of Conservation, cooperating.

second species (*S. leporum*) was described by Crawley (1914) from a rabbit shot at Bowie, Maryland.

Crawley also reported records in the U. S. Bureau of Animal Industry of infected rabbits from Pennsylvania, New York, and Illinois. Dr. E. W. Price, Parasitologist of that Bureau (letter June 26, 1945) states that the Maryland material was from *Lepus sylvaticus*, the New York material from a wild rabbit, the Pennsylvania material from a cottontail, and the Illinois specimens from *Lepus*. Thus *Sarcocystis* has been recovered from cottontails in Maryland and Pennsylvania, and Illinois and New York reports of *Sarcocystis* probably also pertain to cottontails. There are only three subsequent accounts of *Sarcocystis* in cottontails. Le Dune (1936) reported 36 infected of 224 animals examined in New York State in 1935 and 60 of 204 in 1936; he also found *Sarcocystis* sp. in the snowshoe hare. Morgan and Waller (1940) found *S. cuniculi* in 20 of 210 animals examined in Iowa, and Bell and Chalgren (1943) examined infected animals from New York, Virginia, and Missouri.

At the present it seems best to apply the name *S. leporum* Crawley, 1914, to the sarcosporidian of the cottontail rabbit and to consider Brumpt's *S. cuniculi* as a *nomen nudum* since he gave no description of the species he named.

In Minnesota, *S. leporum* is widely distributed in cottontails (*Sylvilagus floridanus mearnsi*). The first record was secured on April 14, 1940, in Traverse County on the South Dakota border. Subsequently, parasitized animals were collected in six other counties in the southern half of the state. Of 78 cottontails examined from April 1940 to May 1945, 30 (38.4%) were parasitized. The infections ranged from very light cases to those in which half of the muscle mass seemed composed of cysts.

Dissected mature cysts placed between a cover glass and slide, measured 4.0 to 5.0 by 0.40 mm.; in paraffin the sections were 0.13 to 0.24 mm. in diameter. They are not nearly as robust as *S. rileyi* of ducks.

If an individual cyst is crushed between a slide and cover glass, hundreds of the characteristic, banana-shaped spores or infective bodies can be seen under the microscope. The spores averaged 12.2 by 4 micra and are slightly wider at one end. The measurements of cysts and spores compare favorably with those given by Crawley.

In cottontails the cysts are most readily seen in the muscles of the hind legs, flanks, and loins. They are not visible in frozen flesh. Light infections are readily overlooked unless special search is made. It is important for hunters to be able to recognize even light infections because the possibility of transmission to man must be considered. Rabbits heavily infected with *Sarcocystis* should not be used, but animals lightly infected are safe for human consumption if well-cooked.

Little is known about the transmission of *Sarcocystis* from host to host. Scott (1943) concluded that *S. tenella* is spread directly from sheep to sheep by fecal contamination.

In attempting to learn the mode of transmission in cottontails, one live-trapped on April 24 and another on April 26, 1941, were placed in a 6×6-foot cage with a domestic rabbit not

known to be infected with *Sarcocystis*. Both cottontails harbored fleas (*Cediopsylla simplex*). One was dead on April 28, apparently killed by the other. The second killed itself on May 1 trying to jump through the wire top of the cage. Both had heavy infections of *S. leporum*.

In the belief that fleas sucking the blood from an infected animal might pick up and transmit spores of *Sarcocystis* to an uninfected animal, the fleas of the cottontails were examined, but they contained none of the characteristic spores. It is probable that spores, if taken up by the fleas, would have had a different form.

Infected tissue of the cottontail that died on May 1 was fed to a laboratory rat which died on January 11, 1942, almost 20 months later; no cysts were found in its muscles.

A third cottontail, trapped on April 29, 1941, was placed in the cage with the same domestic rabbit that had been in contact with the other cottontails. It died on June 19 from an invasion of fly maggots around the anus, and was infected with *S. leporum*. Flesh from this rabbit was fed to a second rat on June 19. This animal was caged with a third rat which received no flesh. Rat No. 3 died on July 16, and no *Sarcocystis* was found in its muscles. Rat No. 2 died on August 29, 1941; no cysts were seen microscopically and none was found in sections of its heart and muscles.

The domestic rabbit, which for 25 days during April to June, 1941, had been in contact with cottontails infected with *S. leporum*, was killed on June 24, 1942. Careful examination revealed a few cysts of *S. leporum* in its loins. It had no external parasites. The rabbit probably acquired its infection from the cottontails by eating food contaminated with their droppings containing infective bodies, rather than by being fed upon by infected fleas.

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PALATABILITY RATINGS OF BLACK HILLS PLANTS FOR WHITE-TAILED DEER[1]

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A preliminary palatability rating has been established for the northern Black Hills of South Dakota based on 162 stomach analyses of white-tailed deer (*Odocoileus virginianus macrourus*) and analysis of the range occupied by these animals. Conclusions have been drawn as to key species for observing range conditions.

Description of Area

The Black Hills occupy about 2,000,000 acres in western South Dakota and northeastern Wyoming. Geologically they consist of a sedimentary dome through which protrudes a central core of granite; northward the sandstone and limestone are pierced by several igneous cones. The sedimentary structure has eroded deeply in the eastern portion, but the western side remains fairly smooth except where cut by streams. The resulting topography changes from rolling slopes in the western limestone to a fringe of steep rugged canyons through which streams emerge at the foothills. The elevations vary from 3,500 to 7,200 feet above sea level.

The climate is characterized by cold dry winters with moderate snowfall, hot summer days with cool nights, and highly variable precipitation. Of the 19-inch average annual precipitation, three-fourths occurs during the April to September growing season. Snowfall normally accumulates to a depth of two to three feet in the western limestone but tapers off toward the foothills until little accumulates except on the northern slopes. The average period between killing frosts varies from 150 days in the foothills to 90 days or less at the higher elevations. The characteristic ponderosa pine cover type is interspersed with frequent grassy parks and meadows, and broken elsewhere by temporary stands of aspen and paper birch. Farming is most common around the foothills, but within the hills there are many small dairy and stock ranches producing hay and small grains. Corn, wheat, barley, oats, and alfalfa are common crops in the foothills. Some 30,000 cattle and 25,000 sheep are grazed on the open range or in fenced pastures during the summer. Both white-tailed deer and mule deer (*O. hemionus*) are increasing rapidly, estimates showing 15,000 white-tailed and 5,000 mule deer. In addition there are some 500 elk (*Cervus canadensis*) outside of park enclosures.

To stay within the limits of adequate sampling, this report covers only 500,000 acres in the northern hills of South Dakota.[2] Compared to the Black

[1] Game wardens, Pittman-Robertson staff members, and forest rangers of the Black Hills area assisted by collecting stomach samples. State Game Warden Dave Harris of Deadwood, South Dakota, gave wholehearted cooperation without which this study would have been impossible.

[2] The timbered and brush areas east of the Wyoming-South Dakota boundary and north of the line between Townships 1 and 2 North, B. H. M., and almost wholly within the Black Hills National Forest.

Hills in general, this area has somewhat higher annual precipitation, greater snowfall and snow accumulation, a denser undergrowth, and larger areas of old burns that break the usual

acres: ponderosa pine, bearberry, ground juniper, aspen, snowberry, Oregon grape, rose, spirea, raspberry, serviceberry, chokecherry, russet buffaloberry, and paper birch.

TABLE 1.—FOOD AVAILABLE AND EATEN BY DEER IN BLACK HILLS, 1941–42.

	Range Composition				*Stomach Analyses*				*Palatability Ratings*			
	Percentage available on the range				*Percentage (by volume) in stomachs*				*Ratio of utilization to availability*			
	Jan.–Mar.	*Apr.–June*	*July–Sept.*	*Oct.–Dec.*	*Jan.–Mar.*	*Apr.–June*	*July–Sept.*	*Oct.–Dec.*	*Jan.–Mar.*	*Apr.–June*	*July–Sept.*	*Oct.–Dec.*
Grasses	12.8	21.3	27.6	23.2	6.5	26.6	2.8	5.0	.51	1.24	.10	.22
Forbs	9.8	14.6	17.8	15.6	8.9	16.4	44.7	25.8	.92	1.13	2.52	1.65
Ponderosa pine (*Pinus ponderosa*)	9.5	5.7	3.8	4.8	2.2	6.8	—	2.3	.23	1.20	.00	.47
Aspen (*Populus tremuloides*)	9.2	5.6	4.0	5.0	tr	9.6	1.8	1.9	.00	1.74	.45	.39
Bearberry (*Arctostaphylos uva-ursi*)	8.1	12.0	11.4	11.0	22.8	15.5	tr	13.5	2.83	1.29	.00	1.22
Snowbrush (*Ceanothus velutinus*)	7.6	4.9	3.6	4.6	6.4	tr	tr	4.5	.85	.00	.00	.99
Juniper (*Juniperus communis*)[a]	7.5	4.8	3.4	4.4	5.3	.1	.1	1.7	.70	.02	.03	.40
Paper birch (*Betula papyrifera*)	4.6	3.0	2.0	2.5	.1	.5	1.2	—	.02	.16	.61*	.00
Rose (*Rosa fendleri*)	4.4	3.7	3.0	3.9	4.6	4.5	24.8	3.6	1.05	1.21	8.13	.93
Serviceberry (*Amelanchier* sp.)	4.1	3.1	3.0	3.2	4.8	4.2	1.4	2.2	1.17	1.35	.46	.68
Hazel (*Corylus rostrata*)	3.6	2.8	2.0	2.5	—	1.7	—	tr	.00	.60*	.00	.00
Snowberry (*Symphoricarpos albus*)	2.7	3.5	3.5	3.5	tr	1.9	.8	tr	.00	.54	.23	.00
Chokecherry (*Prunus melanocarpa*)[b]	2.6	1.7	1.3	1.6	.6	2.3	1.3	.2	.22	1.37	1.04	.15
Oregon grape (*Mahonia repens*)	2.1	3.5	4.0	3.7	17.4	.9	tr	10.2	8.32	.25	.00	2.72
Buffaloberry (*Shepherdia canadensis*)	2.0	1.6	1.2	1.5	—	—	—	—	.00	.00	.00	.00
Oak (*Quercus macrocarpa*)	1.7	1.5	.8	1.0	1.4	1.0	—	.9	.80	.68	.00	.96
Spruce (*Picea canadensis*)	1.5	1.1	.8	.8	.2	—	—	tr	.01	.00	.00	.00
Willow (*Salix* sp.)	1.4	.9	.6	.8	.1	.7	6.1	.8	.08	.74	9.54*	1.00
Old mans beard (*Usnea* sp.)	1.1	.7	.5	.7	1.1	.7	—	.7	1.04	.97	.00	1.00
Buckbrush (*Symphoricarpos occidentalis*)	.8	.4	.4	.4	5.7	2.0	1.5	8.3	7.01	4.90	3.82	21.18
Raspberry (*Rubus strigosus*)	.6	.4	.4	.5	—	.1	.3	—	.00	.26	.69	.00
Sagebrush (*Artemisia frigida*)	.5	.4	.3	.4	.4	.1	—	tr	.78	.17	.00	.03
Spirea (*Spirea lucida*)	.4	.6	.8	.6	—	1.5	.5	tr	.00	2.34	.58	.05
Ironwood (*Ostrya virginiana*)	.2	.2	.1	.2	—	—	—	—	.00	.00	.00	.00
Skunkbush (*Rhus trilobata*)	.2	.2	.1	.1	—	—	—	—	.00	.00	.00	.00
Sumac (*Rhus cismontana*)	.2	.1	.1	.1	.2	—	—	.6	1.00	.00	.00	5.00
Lead plant (*Amorpha canescens*)	.2	.1	.1	.1	—	—	—	—	.00	.00	.00	.00
Grain	.2	.3	1.2	1.6	8.2	tr	1.0	11.7	51.50	.00*	.82	7.47
Red willow (*Cornus stolonifera*)	.1	.1	.1	.1	.6	tr	2.8	tr	4.67	.00	46.00*	.57
Hawthorn (*Crataegus* sp.)	.1	.1	.1	.1	—	—	—	—	.00	.00	.00	.00
Bracken (*Pteris aquilina*)	.1	.3	.6	.5	—	—	—	—	.00	.00	.00	.00
Twinflower (*Linnaea americana*)	.1	.1	.2	.1	tr	.2	—	1.0	.00*	1.55	.00	7.50
Fungi					.3	1.0	5.0	2.2				

* Questionable rating.
[a] Includes creeping juniper (*Juniperus horizontalis*).
[b] Includes pin cherry (*Prunus pennsylvanica*)

coniferous overstory. As a result of the better range, the deer population is higher and several winter concentration areas have one deer per 10 acres or less.

Common woody plants (Table 1) of the major types are:

1. *Mature or dense ponderosa pine*, 150,000 acres: ponderosa pine, bearberry, serviceberry, snowberry, russet buffaloberry, and spirea.

2. *Open ponderosa pine*, 275,000

3. *Northern white spruce*, 10,000 acres: spruce, willow, paper birch, ground juniper, red willow, and twinflower.

4. *Birch-aspen*, 7,000 acres: birch, aspen, willow, serviceberry, hazel, spirea, ground juniper, spruce, chokecherry, pin cherry, and russet buffaloberry.

5. *Oak*, 7,000 acres: oak, hazel, rose, serviceberry, chokecherry, lead plant, sumac, snowberry, ironwood, and creeping juniper.

6. *Recent burns*, 25,000 acres: snowbrush, raspberry, rose, russet buffalo berry, paper birch, aspen, ground juniper, and snowberry.

7. *Open parks*, 26,000 acres: mainly grasses and forbs with borders of buckbrush and rose.

During years of normal or better precipitation the range will generally support the domestic stock now grazed without serious overuse. In past dry years this was not true and even with reduced stocking some overgrazing was evident.

The 1941 and 1942 growing seasons were exceptionally good and forage production was high. Notwithstanding this favorable condition, portions of the winter deer range showed too heavy utilization.

PROCEDURE

After concluding stomach analyses in the first year, it became evident that there were distinct seasonal food preferences. Therefore, the year was divided into four periods of three months each, even though these periods did not conform entirely with the growing seasons. Altitude and exposure offer such variance that, considering all factors, the use of these periods (Jan.–Mar.; Apr.–June; July–Sept.; Oct.–Dec.) seemed to fit conditions as well as any that could be established.

Frequently it was impossible to identify numerous herbaceous species in the stomach contents and the herbs were classified by groups as grasses, grains, and forbs. Bluegrass (*Poa pratensis*) comprised 90 per cent or more of the grasses utilized. The grains were corn, oats, wheat, and barley. Less preference was shown among the forbs.

RANGE ANALYSIS

The area was divided into seven types as named above. Samples were taken in each for estimating production (usually the current annual growth) of each plant species or group. These estimates were totalled by species for the entire area and then converted to percentages (Table 1).

Production estimates were largely ocular, based upon a limited amount of previous experience with clippings and actual weights; they are admittedly crude. Detailed range analyses will give more reliable results, but even these must be changed as seasons differ, utilization varies, and plant succession occurs following burns and cuttings. As a preliminary estimate, Table 1 is considered to be reasonably satisfactory for rating palatability.

In estimating plant production by species (or groups), consideration was given only to a belt within reach of a standing deer, roughly to a height of five feet. Allowance was made for normal snow depth, so that unavailable growth was excluded during the snow season. Estimates were made mostly during the autumn and winter months so that allowance would be made for normal use by sheep and cattle.

STOMACH ANALYSES

The second step was to summarize the stomach analysis data collected in 1941 and 1942. Twenty-two samples were taken from January to March, 26 from April to June, 9 from July to September, and 105 from October to December. No deer were shot for sampling and the seasonal distribution represents the numbers available from

predators, poachers, accidental losses, and legal kills during the November hunting seasons.

Some differences could be seen in the feeds taken on different ranges, particularly with variations in altitude. The small and there are no physical barriers to the movement of deer from any part to another. Similarly, the range analysis was made for the entire area and not to compare the makeup of a small part with the contents of a deer stomach

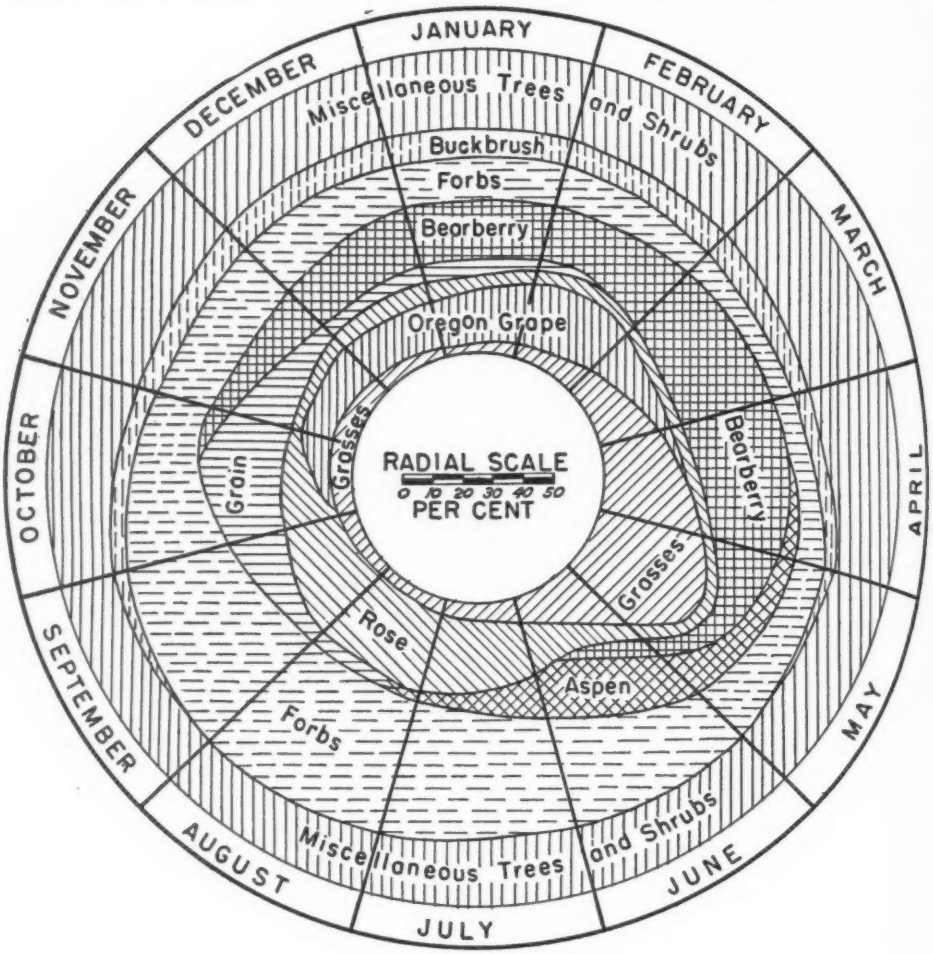

FIG. 1. Changes in diet of deer in the Black Hills by months; width of band indicates relative importance of various types of food.

data herein represent the total of samples taken during a period, combined without respect to locality, because the whole area is comparatively taken from that small area. Along Spearfish Canyon, for example, a deer will feed through an altitudinal range of 1,800 feet in traveling one mile in

horizontal distance. As might be expected, there is some seasonal drift of deer out of the higher limestone area during the winter.

The diet by species or groups during the four selected periods is summarized in Table 1. Some variation may be expected from year to year. Killing frost and snowfall occurred about three weeks earlier in 1942 than in 1941. In the autumn of 1942 feeding was influenced somewhat by farm labor shortage, leaving grain available in the fields that normally would have been stored. The two winters during which the studies were made had light snowfall, and a hard winter undoubtedly would reflect changes in diet. The records for these two years, however, may be most valuable in rating palatability since a minimum of the feed was inaccessible. Study of the data shows that more than half of the food taken could have been covered by a uniform one-foot layer of snow.

One weakness of the breakdown by periods can be shown by the occurrence of aspen in the stomachs. For the period April to June the percentage is 10, while for the month of June when aspen is leafing out this percentage rises to 25. Similarly the occurrence of grass is not uniform throughout the spring period, but rises to a peak in May just before the leaves of forbs and shrubs become abundant. Bearberry, with an average of 12 for the spring period, falls from 32 in April to practically no value in late June. Consequently, Figure 1 gives a better picture of the seasonal feeding habits.

There is also variation in the parts of plants used during different seasons. Through the summer months, rose is highly important, and the new foliage then predominates, but later in the autumn and in early winter the fruits or hips are the parts desired. One outstanding observation is that fruits in general are highly palatable. For example, one species of *Symphoricarpos*, the buckbrush, is favored because of its prolific fruiting, while snowberry produces (or retains) little fruit and is seldom used. Oregon grape appeared in the diet a month earlier in 1942 because of the abundant berry crop in that year. Also apparent is the liking of deer for evergreen foliage during the winter months.

PALATABILITY RATINGS

The foregoing leads to palatability ratings, which can be expressed in the ratio of utilization to availability.[3] If the percentage utilized (as shown by stomach analyses) is less than that available (as determined by range analyses) the ratio will be less than one; if the opposite occurs a rating of more than one results. Thus grasses rate 1.2 in the April to June period, but later in the growing season with more available (both in actual quantity and percentage) the ratio drops to 0.1. Rose, on the other hand, for comparable periods, rises from 1.2 to 8.1.

Some plants of infrequent occurrence either on the range or in the stomach samples show ratings that are questionable, and on the basis of field observation a few changes have been made. In other cases no rating has been attempted. Again, it has not been found practical to estimate the production of

[3] Colorado Game and Fish Commission, 1939–40 Deer-elk survey, Colorado, 3: 57–58, mimeo.

fungi, yet general observations indicate an exceptionally high palatability rating for them. Questionable ratings in Table 1 are marked with an asterisk.

For practical purposes, species and ratings can be grouped as in Table 2.

TABLE 2.—PALATABILITY GROUPINGS* OF DEER FORAGE IN BLACK HILLS.

	High	Medium	Low	Unpalatable
January to March	Bearberry Oregon grape Buckbrush Grain Red willow Old mans beard Sumac	Grasses Forbs Snowbrush Juniper Rose Serviceberry Oak Sagebrush	Ponderosa pine Paper birch Chokecherry Willow Pin cherry	Aspen Hazel Snowberry Buffaloberry Spruce Raspberry Spirea Ironwood Skunkbush Lead plant Bracken
April to June	Buckbrush Spirea Grasses Forbs Ponderosa pine Aspen (late) Bearberry (early) Rose Serviceberry Chokecherry Twinflower	Hazel Snowberry Willow Old mans beard Pin cherry Grain Bearberry (late) Aspen (early)	Juniper Paper birch Oregon grape Oak Raspberry Sagebrush Red willow	Snowbrush Buffaloberry Spruce Ironwood Skunkbush Sumac Lead plant Bracken
July to September	Forbs Rose Willow Buckbrush Red willow	Serviceberry Snowberry Chokecherry Raspberry Pin cherry Spirea Grain	Grasses Aspen Juniper Paper birch	Ponderosa pine Bearberry Snowbrush Hazel Oregon grape Buffaloberry Oak Spruce Old mans beard Sagebrush Ironwood Skunkbush Sumac Lead plant Bracken Twinflower
October to December	Bearberry Forbs Snowbrush Oregon grape Buckbrush Sumac Grain Twinflower	Ponderosa pine Aspen Juniper Rose Serviceberry Oak Willow Old mans beard Red willow	Grasses Chokecherry Sagebrush Pin cherry Spirea	Paper birch Hazel Snowberry Buffaloberry Spruce Raspberry Ironwood Skunkbush Lead plant Bracken

* General basis for ratings (not strictly followed): High, 1.0 and over; medium, 0.5 to 1.0; low, below 0.5; unpalatable, zero.

KEY SPECIES

An important use of the foregoing tables is to determine key or indicator plants as a basis for studying range utilization. Presumably an indicator plant should be one that is fairly abundant and uniformly distributed on the range, that comprises a fairly high percentage of the stomach contents, and that has higher than average palatability rating. Preferably it should receive light use by domestic stock. The use of low palatability plants as indicators will result in too great delay in recognition of a range problem.

The fungi rate high in palatability but are too scarce to use as indicators. Buckbrush consistently rates high but lacks sufficient abundance and uniformity of distribution. Serviceberry is widespread in occurrence but already is so heavily browsed by both wild game and domestic stock that it cannot be used satisfactorily.

For the critical period from January to March, bearberry and Oregon grape (or juniper with deeper snow) would be suitable indicators. Oak may be a better indicator locally in the foothills. In the spring, April to June, bluegrass and forbs could be used, or bearberry for the first month, and aspen for the last. Rose is the outstanding indicator for the July to September period, although the general abundance of all forage at that time (as in the spring) makes the use of indicators less important. During the October to December period, Oregon grape, bearberry, or snowbrush should be satisfactory. Any appreciable browsing of russet buffaloberry, hazel, ironwood, aspen, or skunkbush during a normal winter would warrant close examination of the more palatable species.

SUPPLEMENTAL NOTES ON 1943–44

After the preceding account was written, 157 additional stomachs were sampled but the findings did not materially affect the original calculations. It has been possible, however, to verify and add to the earlier conclusions.

The winter of 1943–44 was extremely severe. Starting in November 1943, snowfall continued heavy through March 1944, with depths on the ground near the foothills from 14 inches in November to 29 inches in January. During that winter and the following spring, death losses from malnutrition in the northern Black Hills were conservatively estimated at 2,500 deer. Stomach analyses of 39 dying during January to March, 1944, served to answer some questions that could only be surmised before. From January through March in normal or moderate winters, plants of high palatability made up 58 per cent of the diet, those of medium palatability 39 per cent, and those of low palatability only 3 per cent. During the corresponding period in 1944 the use of plants of high palatability fell to 32 per cent and of medium palatability to 30 per cent, while the use of those of low palatability increased to 38 per cent. Use of ponderosa pine, for example, rose from less than 3 per cent in the normal winters to 28 per cent in 1944. Of greater significance was the fact that unpalatable species were not used even in 1944 by deer at the point of starvation.

SUMMARY

Stomach samples of 319 white-tailed deer killed in the northern Black Hills from 1941 to 1944 were analyzed and

the percentages of the plant species comprising the diet were compared with percentages available as shown by range analyses. The ratio of utilization to availability has been used to express the palatability ratings. Seasonal preferences varied greatly, necessitating the selection of key species to fit the period concerned.

The winter of 1943–44 was unusually severe and many deer died of malnutrition. Since the deer did not thrive on plants of low palatability and made no use of unpalatable plants, it was concluded that unpalatable plants should be given no weight and those of low palatability little if any weight in calculating range carrying capacity.

MANAGEMENT OF BLACK-TAILED DEER[1]

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Losses in black-tailed deer (*Odocoileus hemionus columbianus*) have been reported periodically during the past two decades from Sitka, Alaska, to Monterey, California, and accounts of increased fatalities in late winter and early spring throughout the range have indicated a common cause.

Unlike mule deer, the blacktail deer seldom migrate long distances. Each individual or local group lives in a small area throughout the year, changing habitat only if forced by persecution or adverse weather conditions.

The entire range of the blacktail as a species lies within a belt where annual precipitation varies from 35 inches at the south to 150 inches in the north. Heavy ground vegetation and dense deciduous or evergreen forests predominate. These deer prefer timbered stands of varying density with marginal openings. In the north they may inhabit spruce woods bordered by muskeg meadow or, at higher elevations, alder thickets near mountain meadows. In Oregon, on the eastern side of the Coast Range, they live in scrub oak stands near open pastures or burns; and on the western side, stands of alder or vine maple near strips of logged or burned-over land are ideal habitat. In these combinations are the two essentials for their welfare—protection furnished by the cover, and food supplied by the clearings.

Death rates are higher as to be expected in parts of coastal Canada and Alaska, where the wintering area is narrowed to strips along watercourses and seashores when snow and intense cold prevail in the higher elevations. In the Oregon coastal range, where deer are not confined to limited habitat, losses are common, and fatalities in northern California coastal areas are reported. Bacterial infection seemed improbable as the cause when reports were received

[1] United States Fish and Wildlife Service, Oregon Agricultural Experiment Station, Oregon State Game Commission, American Wildlife Institute, and Agricultural Research Foundation cooperating. Field assistants were Edward Chatelain, Lee W. Kuhn, Pierce B. Uzzell, Eldon H. Smith, John S. Morse, and James S. Lindzey.

also of deer deaths on islands and in isolated valleys too remote to be exposed simultaneously to infectious diseases.

Such were the conditions in 1939, when the Oregon Cooperative Wildlife Research Unit was asked to study the decreases in black-tailed deer to learn if they might be avoided by changes in management. The present material is a preliminary report.

MORTALITY FACTORS

A first step was to learn whether the widespread deaths might be due to disease. More than 50 autopsies were performed by Drs. J. N. Shaw and M. P. Chapman, Department of Veterinary Medicine, Oregon State College. In no instance was there evidence of an epizootic, although parasites were particularly abundant in emaciated deer from over-grazed grounds, and often hastened the death of animals in critical condition.

The symptoms of affected deer were almost identical throughout the coastal area. The first indications were rough pelage and general poor condition, then listlessness. When approached, the deer tended to run downhill; often if one was cornered and forced to run uphill, it would stop after a weak effort, face its pursuer while showing fear or anger, and stand until able to run feebly downhill. Diarrhea was usually seen in the last stages before death.

Evidence began to indicate that malnutrition was the most probable cause of losses, yet stomachs of the deer invariably were full of the usual winter foods. Losses were greater in areas of closed forest canopy and mature evergreen stands than on logged or burned-over lands. On one study area, an imaginary line could be drawn through the Coast Range, north of which emaciated deer were rare in the natural interspersion of thickets and glades, but to the south, where a closed deciduous canopy prevailed, losses could be anticipated yearly (Pl. 5, A). Most of the latter region was either browsed closely by both domestic livestock and deer or the vegetative stand lacked vigor as a result of the exclusion of sunlight during most of the growing season. The northern area consisted of series of timber stands with adjacent openings, supporting vigorous growths of common deer foods (Pl. 5, B).

TABLE 1.—PERCENTAGE PROTEIN CONTENT OF DEER FOODS, TILLAMOOK BURN AREA, TILLAMOOK COUNTY, OREGON.

	June	*Dec.*
Vine maple (*Acer circinatum*)	12.83	5.31
Red alder (*Alnus rubra*)	11.48	7.49
Salmonberry (*Rubus spectabilis*)	9.42	7.32
Red elderberry (*Sambucus racemosa*)	27.75	9.71
Thimbleberry (*Rubus parviflorus*)	8.58	4.25
Fireweed (*Epilobium angustifolium*)	17.69	—*

* Not available in winter.

NUTRITIVE VALUE OF FOODS

Analyses of the preferred deer foods made by Dr. J. R. Haag, Oregon Agricultural Experiment Station, revealed wide differences in food value under these contrasting growing conditions and a seasonal variation in protein content (Table 1). Deer foods produced under conditions which resulted in a minimum protein content during summer were almost valueless in midwinter. Although the deer were eating

as much bulk as formerly, it appeared that the protein value was so reduced that they received little nourishment. In Pennsylvania, Hellmers (Journ. Wildl. Mgt., 4: 315–325, 1940) found the nutrients in deer foods were lowered in winter. Graf (MS, 1943), during studies on elk in Tillamook and Clatsop counties, Oregon, in 1942, found those animals fed twice as long in winter as in summer, indicating both scarcity and poorer quality of winter foods. Black-tailed deer were also found to be foraging almost continuously on the critical areas in winter.

Many of the favorite food species, like the hedge nettle, common white clover, and fireweed, may be preferred foods in midsummer, but they disappear entirely during the winter. Although commonly found on logged or burned-over lands, they are almost wholly absent from closed canopies or heavily grazed areas. Deer on such lands usually are physically handicapped in winter. On the burned or logged-over lands the browse plants, other than those mentioned, usually are richer in protein, are of more vigorous growth and, in midwinter, still carry sufficient nutriment to sustain deer.

On over-grazed or closed canopy areas in Oregon, malnutrition in black-tailed deer became critical following a long period of dull weather. If the autumn began with heavy rains and persistent cloudiness, two months of such weather would dissipate the reserve fat and strength of the deer. Thenceforth, if the environmental conditions did not change markedly, losses were progressively higher until new vegetation became nutritionally adequate. If, however, the weather became mild and new vegetation began to grow in early or mid-February, a crisis was avoided. On burned or cut-over experimental areas, general losses among deer have not occurred during the period of the study. The high protein value of deer foods grown under satisfactory conditions, as revealed in the chemical analyses, obviously accounts for high deer survival on such habitats.

MANAGEMENT STUDIES

A chance occurred to test this theory in practice in the fall of 1939, when a large area of about 300,000 acres was designated by the Oregon State Game Commission as a temporary refuge in the "Tillamook Burn." A forest fire of unbelievable intensity and destructiveness swept through green timber and previously burned areas, mostly in Tillamook County and east of the city of that name, in late August. This was originally a rugged area covered by a heavy stand of giant spruce, hemlock, Douglas fir, and cedar. With the soil sterilized by the intense heat of the conflagration, it made an ideal study plot. As the result of two severe fires, in 1933 and 1939, less than 5 per cent of the original vegetative stand remained on this vast area and the deer population was reduced to below one animal per section of land. A fortunate heavy rainfall during the last days of the 1939 fire eroded the soil to underlying gravel in many places, but stimulated immediate vegetative growth; in consequence, fireweed shoots, most tempting to deer, appeared within 10 days after the conflagration. The intense heat insured freedom from parasites and improved the areas as deer habitat. A few weeks

A. Closed canopy in black-tailed deer range, Glide, Oregon. Browse or winter food scarce. *B*. Range for domestic animals and deer adjacent to closed canopy, Deer Creek Valley, Douglas County, Oregon. The sheep were affected by nutritional deficiency and parasites. *C*. Natural interspersion of cover and food plants for deer on logged and burned-over lands, eastern Tillamook County, where the Tillamook fires originated in August 1939; photographed May 8, 1943. *D*. Deer browse on burned-over lands, Trask River watershed, Tillamook County, Oregon, May 8, 1943. Photographs by U. S. Fish and Wildlife Service.

after the fire, the establishment of the entire tract and a marginal buffer strip as a sanctuary protected the remnant animals. The area was closed to hunting until September 26, 1942, when about two-thirds of the refuge was opened for hunting male deer only. The remainder was opened in 1943 under the same restrictions.

During the protection period, deer increased from an average of less than one to over 15 per section. Most of the population resulted from natural increase, but some deer moved in from adjacent areas of poorer forage, particularly in the southern part, where populations in 1943 were about 30 deer per section along the Trask watershed in the part closed for four breeding seasons.

There are both advantages and disadvantages in establishing a large temporary refuge. The Tillamook Burn is 20 miles wide in some places. Much of the country was originally inaccessible, but logging roads, too rough for automobiles but suitable for trucks, hikers, and saddle horses, now intersect most of the deer areas. There has been little hunting more than a mile from any road. When the hunting season opened most of the male deer within these strips were soon shot; in 1944 forked-horn bucks predominated, except in isolated districts rarely visited by hunters. Even rough terrain adjacent to a highway seemed to deter hunters.

The total kill in 1943 was estimated at about 3,500 animals, and was much less in 1944, since buck concentrations along roadways, accessible trails, and watercourses had been reduced in the two previous hunting seasons. The breeding potentialities had not been impaired, but large bucks were removed from readily accessible hunting grounds.

During the last days of the 1944 season, several deer were taken and many others seen by game workers in rugged country adjacent to roads, communities and marginal farms. There were signs to indicate that these well-stocked habitats had not been hunted at any time during the open season. Hunters evidently avoid game ranges of difficult terrain or cover, a problem of mounting proportions in game management.

Shooting has been permitted on the Tillamook Burn for three seasons, yet the remaining animals are in fine condition. Over 100 were examined closely during the 1944 season, and all were excellent specimens. The superior quality of the meat favorably impressed hunters seeking blacktails on the coast when hunting was again permitted in 1942, and sportsmen long accustomed to bagging mule deer in eastern Oregon shifted their hunting to the Tillamook Burn.

Close observation on the effect of protection of the Tillamook Burn area, as compared with closed canopy deer habitat, showed that several factors aided the program. Newly cut-over or burned lands provide excellent black-tailed deer habitat. After the first growing season, burned-over areas provide both protection and food in abundance, as reflected in the condition of the animals killed. In 1942, following three years of closure, those in all age classes were considerably heavier than average black-tailed deer. In 1943, when the entire area was opened, the largest deer were taken in the Trask River watershed, which had experienced the longest period of protection (Pl. 5, D).

Of 50 animals taken as random samples from the Tillamook areas, some were of phenomenal weight. Most of these deer represented the older age classes, but the records prove the value of good food conditions for young deer as well (Table 2).

TABLE 2.—AGE CLASSES AND WEIGHTS OF 50 MALE BLACK-TAILED DEER SHOT ON TILLAMOOK BURN, OREGON, 1943.

Estimated Age, in Years[a]	*No. Age Class*	*Average Weight in Pounds*[b]	*Extremes*
2	12	134	102–177
3	11	174	160–187
4	19	201	183–215
5	7	242	215–310
6	1	225	225[c]

[a] Ages estimated by condition of antlers and teeth, and general appearance.

[b] Weights are of hog-dressed carcasses. Some were obtained from records of locker plants where deer were taken for storage and weighed, on state inspected scales. Others were from the Oregon State Police Game patrol. Francis P. Schneider, Oregon State Game Department, cooperated in compiling this information. There have been many later reports of large deer taken on the Tillamook Burn, one of 258 pounds and another of 315 pounds.

[c] Vernon Bailey in "The Mammals and Life Zones of Oregon," (North American Fauna No. 55, p. 87) writes: "Weight of large bucks about 200 pounds, but there are records of 200 and 219 pounds dressed."

In the rugged terrain of the Tillamook Burn, the importance of water supplies is readily apparent. In the flat basins or plateaus, water is used only sparingly by deer, but where the habitat is extremely rough and slopes are steep, a water supply was found to be quite important and often used, as attested by well-beaten paths; even small seeps had numerous daily visits from the deer living nearby. Perhaps one of the greatest aids to better distribution of black-tailed deer in places where water is scarce would be to develop suitable supplies, even in limited quantity.

The acreage in this temporary refuge was such as to make adequate protection possible with only limited patrolling, as few public roads passed through the refuge. Along these there was evidence of only an occasional poacher. Poaching was at a minimum elsewhere and did not appear to affect population trends to any extent. After studying human influence in the Tillamook Burn district, it appears that patrolled temporary refuge units of more than 10,000 acres would have little poaching pressure except by roadside hunters.

In certain ranges it may be desirable to set aside small burns or logging slashes for increasing black-tailed deer concentrations, but sufficient additional land suitably bounded by roads, watercourses, or ridges, should be added. Natural or obvious boundaries will help prevent trespassing. On small tracts the chances for success are increased greatly by intensive patrol. Tracts as large or as fortunately situated as the Tillamook Burn can be successfully patrolled at a much lower cost proportionally than the smaller areas.

If hunters would utilize all of an area and not restrict themselves to the road borders, deer of excellent size and weight could be bagged every year, but in some places it may be necessary to build trails before this can be accomplished. Hunting near roadways yields a predominance of young deer, as forked horn and spike bucks travel with the does and their fawns. Only upon the approach of the breeding season do the larger bucks venture from hiding to join the does.

The Tillamook Burn will be pro-

ductive for several years, but hunting will become more difficult as the vegetative stand increases. As the forest canopy closes in, the nutrient content of the food probably will decline, as suggested by the protein analyses. By 1949 this area may be no more productive than other areas of Oregon approaching the climax type.

MANAGEMENT POSSIBILITIES

Experiences on the Tillamook Burn indicate that rapid deer increases can be expected on cut and burned-over areas when properly protected. Sufficient logged or burned-over land areas develop in Oregon annually to be the basis of a sustained yield program. With little investment, suitable areas of large acreage could be set aside as temporary refuge units. More attention should also be devoted to retaining nuclear herds of deer while logging is in progress. Rarely does sufficient breeding stock remain on deer habitat when logging is completed. The process of restoration is thus under a great handicap.

The policy of establishing temporary refuges on suitable deer habitat will be an effective means of building up herds for the first two or three years immediately following logging operations or fires. This should only be done after surveys have determined suitable tracts. Periodic inventories will indicate when harvests are permissible. Cooperation with land management bodies would help to eliminate sales of land or timber in units too small for effective management. Such a program of logging on public lands could result in the redistribution of deer to areas free from parasites and with sustaining deer foods.

Much potential habitat throughout northern California, Oregon, and Washington is now wasted. In Oregon, if blacktails could be established in all the available open areas bordering timber stands of the Coast Range, many acres of non-productive cut and burned-over lands would be put to practical use.

SUMMARY

The black-tailed deer can live in comparative security in circumscribed areas, making the species the most desirable big game in the Oregon Coast Range; it requires careful but simple management.

Protection of remnant stock after forest fires is essential. Hunting on burned areas before vegetative cover again affords security may eliminate remnants and handicap restoration.

The experiences gained on the Tillamook Burn prove the practicability of a temporary refuge to improve hunting.

The vegetative succession that followed a forest fire on such range provides deer foods of excellent quality in abundance, as shown by the weights of the deer.

The necessary protection period is comparatively short. A closure from October 1939 to October 1942 resulted in increases averaging from less than one to more than 15 deer per section of land. Inspection of deer carcasses killed by the hunters showed them to be free from injurious parasites, a direct result of the fire.

SUMMER BROWSING BY DEER ON CUT-OVER HARDWOOD LANDS

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The white-tailed deer (*Odocoileus virginianus*) has the reputation of being a highly selective feeder, nibbling daintily on one plant, browsing heavily on another, completely ignoring a third. This tendency is most pronounced in summer, when deer consistently choose a relatively few plants from among the vast array of green stuff available in field and forest. The selection is not always specific; it may also be based on the condition or origin of the material. Mitchell and Hosley (1936) have shown that the leaves of plants receiving various fertilizer treatments are subject to differential browsing. The writer (Cook, 1939) has previously reported that sprouts grown under partial shade appear to be acceptable over a longer period than those grown in the open. Empirically, we know that these things are so, even though we do not know why, for as Leopold (1937) so aptly says, "even the most scientific food-habits research tells us *what* has been eaten, but not always how much, and never for what reason." The practicing wildlife manager must know something about this selectivity if he is to produce the maximum of acceptable forage, even though he may not know the underlying reasons for the selection. It seems appropriate, therefore, to report certain observations concerning the selective feeding of deer, on the basis of plant origin as well as of species.

During operations on the writer's forest near Stephentown, Rensselaer County, New York, some five acres of low-grade hardwood stands have been converted by clear-cutting, followed by planting to larch and spruce. These stands had originated on old fields and were composed chiefly of grey birch (*Betula populifolia*), aspen (*Populus tremuloides*) and soft maple (*Acer rubrum*), with a scattering of the better hardwoods and a strong understory of shrubs and hardwood seedlings. This region is especially favorable for plant growth, the flora being both varied and vigorous. The three previously-mentioned trees are notorious sprouters, so that cut-over woodlands are quickly reclothed in green. As a result, cut-over areas have been very attractive to deer, especially for summer and autumn feeding. Until recently shelter in the vicinity has been deficient, so that the deer have wintered elsewhere. The oldest cutting was made in 1940, the latest in 1945.

During clear-cutting, substantially everything, not excepting the larger shrubs, is downed, the wood removed, and the brush burned or piled in staked windrows. When spring comes, the areas are planted to softwoods. With the first surge of new growth, the cut stumps of trees and shrubs sprout vigorously. Annuals and perennials spring up everywhere. By mid-July, deer begin to feed in the slashings. This is also the season when planted trees must be freed from excessive competition; all unwanted trees and shrub sprouts are then mowed down. Gen-

erally, this cleaning must be repeated in the fourth or fifth season. These operations have afforded opportunity to observe the season, the selectivity, and the effect of deer browsing on cut-over hardwood land.

Deer were rare in this area until the time of World War I. The next decade saw the development of a considerable population, until they could properly be rated as abundant. That status they have maintained down to the present, but the population has never been excessive and there has been no evidence of over-browsing of the range.

Even on a block as small as half an acre, deer did not forage everywhere, but restricted their travels to certain fairly well defined paths. The pattern of use was determined, at least in part, by the presence of such obstructions as brush piles, stone heaps, and dense patches of brambles, as well as by the location of trails coming into the clearing from the adjoining forest. In consequence, arbitrary samplings, such as strips counts, were deemed to be of limited application. Rather, broad groupings based on continuous observation as the work of cleaning progressed, have been used to indicate both relative desirability and relative availability of forage. Such groupings are sufficiently accurate for management purposes because the difference in plant composition between stands far exceeds the variation in other factors.

Logging was done during the dormant season, October to May. New growth of hardwoods commonly begins early in May, but the sprouts are not big enough to be used by deer until mid-July. Table 1 indicates the relative attractiveness of new sprouts from winter-cut stumps as well as their relative abundance. Although incomplete, this list includes all important woody plants found on the cut-over areas. No attempt has been made to assess the abundance or use of the rich and varied flora of herbs and grasses. By far the most abundant green things were the fronds of the hay-scented fern (*Dennstedtia punctilobula*), which the deer did not touch.

TABLE 1.—PRESSURE OF SUMMER DEER BROWSING ON FIRST-YEAR HARDWOOD SPROUTS IN NEW YORK.

Browsing pressure	*Species*	*Relative abundance*
UNBROWSED		
	Brambles (*Rubus allegheniensis*)	Abundant
	Ironwood (*Ostrya virginiana*)	Uncommon
	Blueberry (*Vaccinium* spp.)	Uncommon
	Meadowsweet (*Spirea latifolia*)	Uncommon
LIGHTLY BROWSED		
	Aspen (*Populus tremuloides*)	Common
	Sumac (*Rhus typhina*)	Common
	Soft maple (*Acer rubrum*)	Common
	Black cherry (*Prunus serotina*)	Common
MODERATELY BROWSED		
	Red oak (*Quercus borealis maxima*)	Common
	Alternate-leaved dogwood (*Cornus alternifolia*)	Common
	Beech (*Fagus grandifolia*)	Uncommon
	Chestnut (*Castanea dentata*)	Rare
	Basswood (*Tilia americana*)	Rare
HEAVILY BROWSED		
	Grey birch (*Betula populifolia*)	Very abundant
	Hard maple (*Acer saccharum*)	Common
	White ash (*Fraxinus americana*)	Common
	Arrowwood (*Viburnum dentatum*)	Common
	Fire cherry (*Prunus pennsylvanica*)	Uncommon
	Apple (*Malus pumila*)	Uncommon
	Thornapple (*Crataegus* spp.)	Uncommon
	Shadbush (*Amelanchier canadensis*)	Uncommon

It was apparent that there was no correlation between plant abundance and use on these plots. During the initial year, grey birch sprouts, aspen suckers, and brambles were the most

abundant woody plants. The first was heavily fed upon, but the others were browsed lightly or not at all. Conversely, fire cherry, apple, shadbush, and thornapple, all uncommon, were especially sought out. Nor was there agreement between the pattern of summer use and that of winter. Sumac and soft maple, both favored winter foods, were but lightly browsed in summer. White ash, heavily browsed in summer, was little used in winter. A high degree of selectivity was evident. The deer sought out and fed upon the plants they liked best, so that only rarely did an individual escape. Regardless of their abundance, other plants were browsed more lightly or completely passed by.

The preceding discussion concerns hardwood stump sprouts, seedling sprouts, and root suckers but not seedlings. On these logging areas, seedlings of white ash, red oak, soft maple, hard maple, and black cherry were numerous; yet none of them appeared to be attractive to deer. This was especially conspicuous in the case of white ash, where seedlings went untouched, even though closely adjacent sprouts were heavily used. Mitchell and Hosley (1936) have pointed out that, in the case of nitrogen-fertilized dogwood (*Cornus florida*), the best correlation was between deer use and the amount of reducing sugar in the leaves. Perhaps the large amount of elaborated food stored in the roots of cut trees produces sprouts with appreciably different chemical composition. Whatever the underlying reasons for the difference in acceptability, it is sufficient here to note that such a difference exists.

The effect of a thorough cleaning in the middle of the first growing season is to reduce materially the vigor of the stumps. Some die and others put out new shoots that fail to survive the autumn frosts; the next spring a new but feebler crop appears. These, too, seem to be acceptable summer browse and are readily eaten by deer for at least the next two years. Thereafter such shoots decline in value as summer food, although retaining their worth for winter use so long as they remain within reach.

Summer feeding by deer seriously affects new hardwood sprouts, for it takes place when they are most vulnerable. Heavy use of the many-sprouted grey birch may so retard this species as result in production of acceptable browse for a period longer than usual. If undisturbed, these birch sprouts grow too coarse and too tall for deer food in only three or four years. Other species, especially such valuable timber trees as white ash, hard maple, basswood and red oak, may be set back seriously. However, the writer has often observed that these better hardwoods, even after several years of browsing, manage to get beyond reach of the deer and thereafter grow with normal rapidity.

Where low-grade hardwood forest land is in process of conversion, only the best seedling sprouts are preserved in mixture with the planted softwoods. Any agency tending to retard the development of the innumerable sprouts and suckers saves just so much hand labor. Pearce (1937) has shown that where deer concentrate in winter, their feeding may selectively remove all but the most unpalatable species. In summer, deer are more widely dispersed and

the amount of food is infinitely greater. Consequently, the effects of feeding will be similar in pattern but much lower in intensity. In the laborious operation of plantation cleaning, however, every little bit helps. Where the forest is being regenerated by methods involving heavy cutting, hardwood reproduction is usually so abundant that deer browsing does not seriously affect the success of the operation.

SUMMARY

On recently clear-cut hardwood forest land in Rensselaer County, New York, white-tailed deer have exhibited marked selectivity in summer feeding. New sprouts of grey birch, hard maple, and white ash and of several less abundant species were heavily fed upon, while other trees and shrubs were lightly used or completely ignored.

Small seedling trees were definitely less attractive than new sprouts of the same species.

Where such cut-over land is being converted by planting conifers, deer browsing may be of some assistance in keeping down the hardwood sprouts. Where regeneration is being sought by any method involving substantial opening of the forest canopy, hardwood reproduction will usually be so abundant that deer damage will be of little consequence.

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FILING NATURAL HISTORY SLIDES[1]

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Widespread interest in color photography and the increasing use of 2×2 inch kodachrome slides in classrooms and entertainment halls has induced many photographers and organizations interested in wildlife conservation to acquire collections of natural history projection slides. This interest and use of color projection film undoubtedly will expand under the stimuli of new types of color film and the numerous subjects included in the wildlife field.

The problem of locating certain slides for a lecture usually is recognized before the collection exceeds one hundred slides, but can be minimized by cataloging and filing the transparencies in much the same manner as a collection of literature.

Most of the subject material may be readily classified under either the

[1] R. E. Trippensee, Massachusetts State College, Amherst, Massachusetts, and John D. Dwyer, Union University, Albany, New York, made helpful suggestions in the preparation of this manuscript.

Plant Kingdom or Animal Kingdom, then arranged under the group headings of the two kingdoms following the categories recognized by botanists and zoologists. The use of Latinized headings in these categories is optional; persons unfamiliar with scientific names may find common names more satisfactory, such as Fish for Pisces, or Birds for Aves, etc. Slides not strictly dealing with plant or animal materials may be filed under General or Miscellaneous.

Kodachrome No. II-E-5
Subject: Eastern Screech Owl, Otus asio naevius, in red pine tree.
Location: Newington, Conn.
Exposure: f 9.3, 1/25 sec. Filter: None
Photographer: Gordon T. Woods Date: 1-5-44
For additional information see back of card; also Bent (1938) Life Histories of North American Birds of Prey (Pt. 2), U.S. National Museum Bul. 170: 243-259.

FIG. 1. *Left.* Arrangement of slide label and file symbols thereon when in position for projection. Corresponding file card listing photographic data and other information.

There should be relatively little uncertainty as to the group in which a slide should be placed. For example, a scene depicting a hunter and his dog would belong under Recreation, as would a trapper following a watercourse, although the latter activity is often a business. A closeup of the object of the chase should be filed in the group Aves or Mammalia, etc. Pictures of plant or animal habitats can either be grouped separately or under the group to which the plant or animal, whose habitat is shown, belongs.

The following broad categories may be used, and more detailed materials filed under additional categories or subgroupings as the nature and volume of the slide collection may dictate.

I. Plant Kingdom. A. Thallophyta (Algae and fungi). B. Bryophyta (Liverworts and mosses). C. Pteridophyta (Ferns). D. Spermatophyta (Gymnosperms-pines and their allies) (Angiosperms-flowering plants).

II. Animal Kingdon. A. Invertebrata (Animals without backbones). B. Pisces (Fishes). C. Amphibia (Amphibians). D. Reptilia (Reptiles). E. Aves (Birds). F. Mammalia (Mammals).

III. General. A. Restoration (Erosion and soil conservation practices, wildlife research, water managment, and forestry and agricultural practices as they affect wildlife). B. Recreation (Hunting, fishing, trapping, picnicking, canoeing, horseback-riding, and hiking). C. Habitats (Both plant and animal environments).

To prepare and arrange the slides, a small gummed label, on which key symbols are inscribed, is fastened to the

upper right corner of each slide (emulsion side facing you) when in projection position. In my collection, Slide I-A-4, of a fungus (*Amanita muscaria*), is kept in the fourth slot of the file containing pictures of the Plant Kingdom under the group Thallophyta to which the key letter A has been assigned. Another, Slide II-E-5, of an Eastern screech owl, is placed in the fifth slot of the Animal Kingdom file under the group Aves, for which the key letter is E.

This system obviously limits the number of lettered categories in each of the three main groups to 26. A slight modification of the system by using double (HH) or triple (HHH) letters provides for 52 to 78 categories, respectively, in each such group. If a greater number of groupings is needed, the marking might take the form 1H-, 2H-, 3H-, etc. A combination of these two modifications (1HH-, 2HH-, 3HH-, etc.) would seem well adapted for slides of plants and invertebrates where the number of orders, families, genera, and species is large. If, however, the entire collection is such that all slides can be filed under 26 categories or less, it would be simpler to assign a letter to each category and omit the Roman numerals to designate a general group (thus A-4, E-5, etc.). The use of symbols makes it possible to record quickly the slides shown in any meeting, and reference to such notations should prevent reshowing many of the same at subsequent gatherings.

Any system is valueless unless the symbols on the slide label are duplicated in a notebook or on cards which also list the essential data: subject, location, date, photographic record, photographer, and other notes of interest. A small loose-leaf notebook is suitable for a collection of 200 slides; if the collection is larger, or is anticipated to exceed this number, it would be wiser to place the necessary information on 3×5 or 4×6 inch cards (Fig. 1), the size to be used depending on the amount of data to be recorded. This method for indexing information about individual slides enables the person who is to show the slides to select and remove the pages or cards from the file and, after picking out the slides with corresponding symbols, hold the recorded information for study before projection time. Otherwise, one may forget important details of a photograph made several years previously or certain interesting facts pertinent to the life equation of a specific plant or animal. Duplication of slide symbols on file cards also may be of assistance in determining the nature of slides loaned or missing, and provide a clue as to their location. An orderly arrangement of the slides and file cards will be appreciated best by persons whose time for preparation is limited.

BRIEFER ARTICLES

REACTIONS OF YOUNG BIRDS TO ATMOSPHERIC HUMIDITY

Studies have been made of the reactions of various animals to differences in atmospheric humidity, but we know of no observations on the reactions of young birds until the work here reported was done. The apparatus for the control of humidity has previously been described (Shelford, 1929). The earlier work was done in the long, narrow cage. A gradient of humidity extended from one end to the other in three steps. Animals tend to go from end to end of such a tank. This required an animal moving into the high humidity end e.g., to turn around in order to explore the tank further. In some cases there were contact reactions and the time spent in the ends was of necessity different from that in the center (Fig. 1). To eliminate this difficulty, a circular gradient was devised. There were two very gentle flows of air of medium atmospheric humidity between the moist and dry sections.

The junior author performed many experiments on newly hatched domestic chicks; the graphs (Fig. 2) herewith are characteristic. A number of young pheasants from the Illinois State Game Farm secured through the courtesy of Dr. R. E. Yeatter were studied by the senior author because a second shipment was necessary before the experiments were feasible. Due to difficulty in keeping chicks of the wild species alive during shipment, only three good experiments were made with pheasants. These were, however, in excellent agreement and the reactions were especially definite.

The reactions of these young birds are

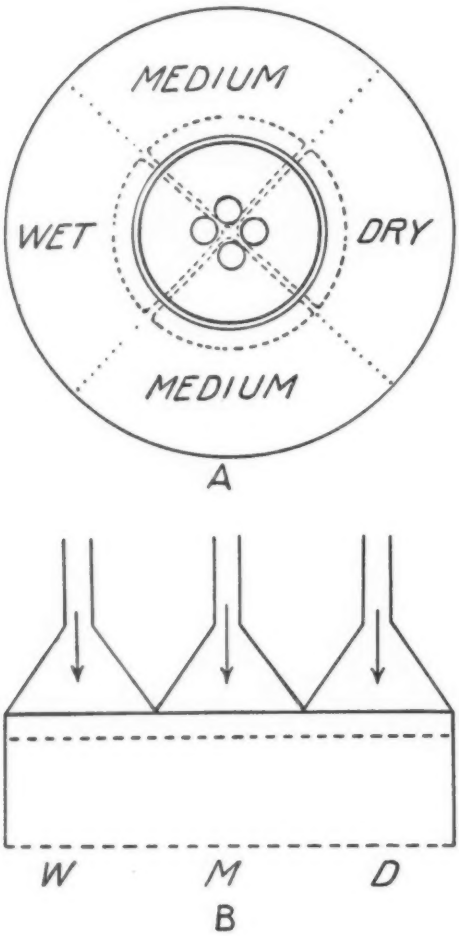

FIG. 1. *A*. Ground plan of the circular gradient used. Small circles near center represent four pipes which conducted air to the apex of funnels turned at right angles and opening as slits behind a screen separated from the cage space (containing the words wet, dry, medium). A ring of plate glass covered the cage. A hood with observation slits carrying symmetrically placed red lights, covered the apparatus. Animals were graphed as in the long cage (B).

B. Cage originally used. In each graph of Fig. 2 the distance between two time scales represents the length of the cage, and two vertical lines separate the three kinds of air (e.g., R.H. 88, 70, 40%) forced across the cage. In this apparatus the graphing consisted in moving the recording pencil down as time passed and to the right or left as the animal moved.

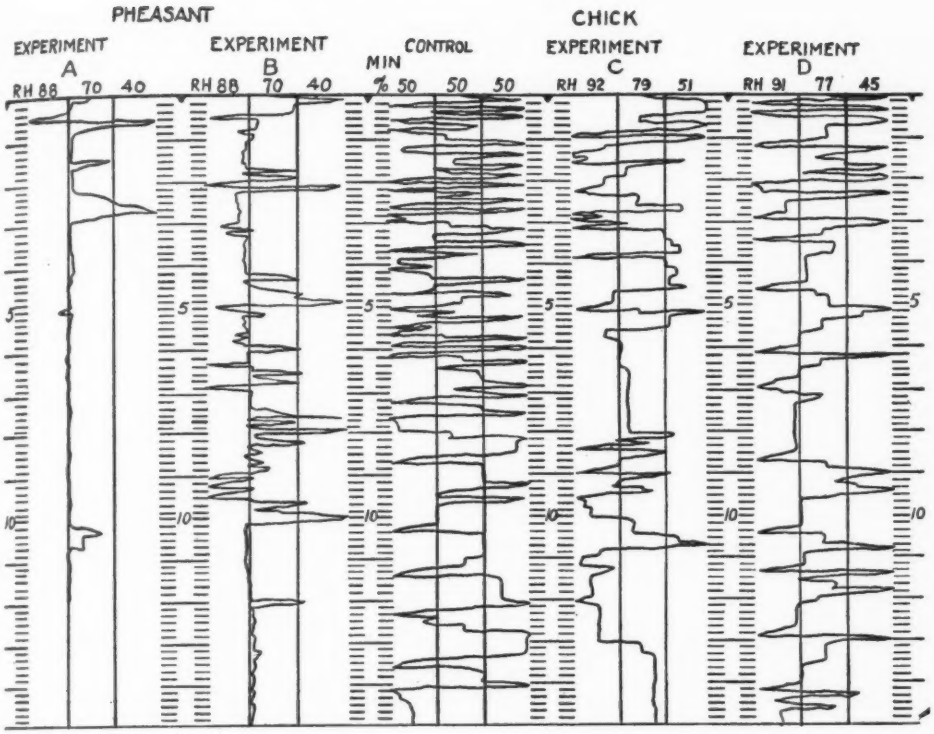

FIG. 2. Reactions in typical experiments: Pheasant, *A* and *B*; chick control, and experiments *C* and *D*, as graphed in circular cage. An animal was marked as turning around in moist air whether it turned or passed through such air. The pheasant in graph *A* usually was put in the air of medium humidity (center front), went into the middle of the wet air, quickly turned back, passed through the medium, and dashed rapidly through the dry air, to be at the center by the end of 30 seconds. It reached the dry side of the medium air at the end of one minute and remained there for 30 seconds, etc. For further explanation, see text.

shown in Graphs A and B (Fig. 2) from top to bottom, with the distance between the right and left scales representing the distance from the beginning of the moist air to the end of the dry air. Each graph was made just as would be done in using a long narrow tank. The young pheasants avoided the dry air, and selected that of medium humidity in a striking manner. They showed definite choice of a point estimated as 79 ± per cent relative humidity with considerably more precision than characterized the action of the domestic chicks. In Experiment A the pheasant was not very active but avoided both the dry air and the wet air in the fashion characteristic of representatives of the various animal groups from paramecium (temperature only) to mammals. The second invasion of the drier air was a shorter penetration than the first. Following a short rest, there was a quick third trip through the dry air; after seven minutes, a short movement in that direction followed and then the bird turned back. The first entrance into the wet air was not repeated for nearly five minutes. Experiment B shows an excited bird which spent 10 minutes exploring the cage but still spending most of its time at 79 ± per cent. At the end of 10 minutes, the typical reaction began, i.e., making the sec-

ond penetration into the rejected condition shorter than the first. This is commonly considered to result from increased sensitivity caused by contact with the stimulus. It may be described as full contact followed by cautious approach. In the controls, the pheasants went from one area corresponding to the several humidities of the experiments to the other in essentially the same manner as did the domestic chicks, shown in Graph C.

In Graphs C and D the domestic chick moving rapidly through the moist and dry air, spent most of its time in the air of relative humidity from 77 to 92 per cent. Long domestication and brooder rearing may have modified this species. The vertical portions of the graph lines (which represent rest periods) show more variation as to location in the humidity gradient than in the case of pheasants. The lack of avoidance of moist air is striking as compared with the latter birds. The two pheasants made eight trips across the moist air, and the chicks 24 in all. The chicks prolonged their stay four times.

Descriptions in the literature of the habitats of the wild ancestors of these two species do not separate the nesting sites from the general range occupied; and the original vegetation is not distinguishable from the secondary. These two conditions render interpretation of nesting conditions difficult. Blanford (1898) says that in the wild state in India, *Gallus bankiva* nests near the end of the dry seasons and the young birds would be somewhat older than those used in our experiment, when the heavy rains normally occur. The young chicks, however, showed markedly less avoidance of high humidity than the phesants. The pheasants of game farms are a mixture of two principal species, but predominantly Asiatic pheasants from dry central Eurasia crossed with ring-necked pheasants from north China, where the climate is much drier than in India. Their reactions suggest ancestral physiological characters related to the environment. Sheep and some other domesticated mammals (Johnson, 1924) have retained physiological characteristics of the wild ancestral forms.

It is also evident that these young terrestrial birds would be led to avoid too dry situations or places where evaporation is high, a condition optimum for the species just as in the case of mice and various invertebrates (Shelford, 1918, 1929).

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—V. E. SHELFORD and LENORE MARTIN, *University of Illinois, Champaign, Illinois.*

MUSKRATS OF TULE LAKE REFUGE, CALIFORNIA

In 1930, 22 pairs of muskrats (*Ondatra zibethica*) were introduced into Tule Lake, in Siskiyou and Modoc counties, California (Twining and Hensley, Calif. Fish and Game, **29**: 64–78, 1943). The marsh evidently was well suited to their requirements, for the animals prospered to where trapping was begun in the winter of 1934–35. The Tule Lake muskrat is large and its pelt is considered one of the best in the nation by fur buyers.

The data given here are of muskrats trapped under supervision of the U. S. Fish and Wildlife Service from December 1, 1943, to February 28, 1944. The specimens were taken to the fur shed near the refuge headquarters for skinning, drying of pelts, and division according to the trapping program. The quota for the Refuge was set at 25,000 and each trapper was limited to a take of 1,000. The government's share was 50 per cent of the 23,155 taken. Sex and age data

were recorded on 1,530, including adults and subadults (Table 1). The latter were classified as to age and sex according to the characteristics given by Baumgartner and Belrose (Journ. Wildl. Mgt., 7: 77–81, 1943).

Sex and age ratios. There were 841 males and 689 females among the trapped animals examined, a sex ratio of 55:45 (122:100). The preponderance of males agrees with data obtained by most of the investigators listed by Dozier and Allen. (Journ. Wildl. Mgt., 6: 294–300, 1942). Among the subadults the sex ratio of males to females was 57:43 as compared to a 50:50 ratio among the adults. This would seem to indicate a higher mortality of males than females in the first year of life.

Weights. The animals were weighed on a lever balance (graduated to half ounces) as soon as possible after being brought from the traplines, usually within 24 hours after having been caught. They usually were damp and some were wet, but the latter were scattered equally among the sex and age groups. Any weight differences resulting from wet muskrats probably were more than offset by the blood lost by those found alive and killed when taken from the traps. Some trappers killed the animals in a manner that caused bleeding, believing the carcasses then would skin out better and easier.

There was considerable overlap in weights, by age and sex, and the average differences were too slight to serve in separating the animals by groups. Measurements on 205 specimens, showed similar overlap as to sex and age groups.

Upper incisors. In reviewing characteristics of possible use to determine the approximate age of a muskrat (providing only a portion of the animal, including the teeth, was found), the width of the upper incisors at the gum line was measured. The average and extremes were determined for 275 animals and showed fairly definite segregation between adults and subadults. The most frequent width of incisors in subadult males was 7.0 mm., 15 being recorded. Of the subadult females, 10 each had incisor measurements of 6.9 mm. and 7.0 mm.; the most frequent width of incisors in adult females was 8.0 mm. with 10 being recorded; 4 adult males had incisor widths of 9.1 mm.

Such characters might be valuable for examining skeletal remains in predation studies.

Placental scar counts. One hundred adult females were autopsied and the scars of

TABLE 1.—RECORDS ON MUSKRATS FROM TULE LAKE, CALIFORNIA, 1943–44.

	Subadults		Adults	
	Males	Females	Males	Females
Sex	653 (*43%*)	502 (*33%*)	188 (*12%*)	187 (*12%*)
Number weighed	280	213	96	106
Weight, pounds	2.0 (1.09–2.91)	1.9 (0.94–2.66)	2.58 (1.78–3.91)	2.38 (1.66–3.31)
Number measured	60	46	47	52
Total length, mm.	572 (515–617)	547 (470–595)	606 (554–674)	595 (554–623)
Tail length, mm.	273 (261–312)	267 (235–299)	297 (267–331)	290 (242–318)
Hind foot, mm.	83(78–87)	83 (75–87)	84 (80–89)	83 (78–87)
Number measured	103	72	30	40
Upper incisor width at gums, mm.	7.0 (6.1–8.5)	6.9 (6.3–7.8)	8.6 (7.8–9.7)	8.2 (7.5–9.5)

placental attachments counted in each (compare Stuewer, F. W., Journ. Wildl. Mgt., 7: 60–73, 1943). The numbers ranged from none in 5 individuals to 26 in one female, and averaged 14.05. The number of uteri containing 14 scars was also most frequent, 17 being recorded, with 15 per uterus next, and 18 third in frequency.

In Table 1 there are 187 adult females and 1,155 juveniles on which sex and age data were recorded, a ratio of 1:6.18 of adult females to all subadults. If trapping gives a true cross section of the age classes, this would indicate a survival of 6.18 muskrats to harvestable age of those produced by each adult female during the breeding season. Subtracting this number from the average total potential of 14.05 for each adult female, as indicated by placental scars, there was an indicated loss of 7.87 young (55.7%) from birth to the trapping season.

Size of testes. There was evidence of early breeding potentially in late January and early February when the testes of adult males were enlarging. On February 4 a white sperm plug was seen on the tip of the penis in one male. The testes were measured when such plugs were common on adult muskrats; it was evident that the testes of subadults were enlarging. The extreme measurements of the testes in adult males on February 10 were from 19–32×9–16×5–9 mm.; in adult males on February 12 the ranges were 27–37×16–23×6–8 mm.; and in subadult males on February 12 were 21–32×8–18×5–8 mm.—CLARENCE A. SOOTER, *U. S. Fish and Wildlife Service, Tule Lake, California.*

PARASITES OF OHIO MUSKRATS

Parasites of the muskrat (*Ondatra zibethica*) have received considerable study, but little in Ohio. From March 20, 1943, to March 22, 1945, 70 Ohio muskrat carcasses were examined, most of them being obtained from trappers by Merrill C. Gilfillan, Leader of the Pittman-Robertson Muskrat Project in Ohio. The specimens were from seven localities: Lake Erie Marshes (28); Killbuck Valley Marsh (17, lacking liver and lungs); Walnut Creek (19) and Whetstone Creek (2), (Morrow County); Buckeye Lake (1); Little Scioto River, Marion County (1); and Union County near Marysville (2).

The trematodes found were: *Echinostomum coalitum*, *Notocotylus quinqueserialis*, *Wardius zibethicus*, and *Plagiorchis proximus* (Barker and Beaver, Journ. Parasitology, 1: 184–197, 1915). The nematodes were: *Capillaria ransomia* and *Trichuris opaca* (Barker and Noyes). There were cysticerci of *Taenia taeniaformis* and a number of adult cestodes, mostly *Hymenolepis*, but others not yet identified.

The pertinent data concerning these are shown in Table 1.

Only one adult *Capillaria* was found in the small intestine; the remainder were evidenced by ova present in the liver tissue, identified in stained 10-micra sections of the latter. The presence of *Capillaria* ova was detected grossly by tortuous white lines on the surface of the liver. No adults were discovered despite careful search.

There was little evidence of pathological conditions. One muskrat contained a large subcutaneous abscess, probably the result of fighting. In another, from Lake Erie Marsh, there were nodules on the lungs; sections of the latter showed this animal was suffering from croupous pneumonia and had an adenocarcinoma of the lung.—ROBERT L. RAUSCH, *Wildlife Research Unit, Ohio State University, Columbus, Ohio.*

TABLE 1. PARASITES OF OHIO MUSKRATS.

Parasite	*Location*	*Hosts infested*	*Number of parasites average; extremes*		*Percentage of infestation*
E. coalitum	Small intestine	45	9.52	(1–81)	*64*
N. quinqueserialis	Caecum	34	8.91	(1–111)	*48*
W. zibethicus	Caecum	16	1.01	(1–14)	*23*
P. proximus	Small intestine	3	3.2	(2–220)	*4*
T. taeniaformis	Liver	4	.12	(1–6)	*6*
T. opaca	Caecum	1	.01	(2)	*1*
Adult cestodes	Small intestine	18	.47	(1–6)	*26*

BOX TRAP FOR SNOWSHOE HARES AND SMALL RODENTS

In order to successfully live-trap snowshoe hares in sufficient numbers to study their daily and seasonal movements during a recent investigation in Minnesota, it was necessary to build traps that were compact and light enough to be transported easily through brushy cover, that could stand rough handling, that would give protection to the captured animal from rain, snow, and wind, and that had all the working mechanism inside so that the trap could not be tripped by any animal from the outside.

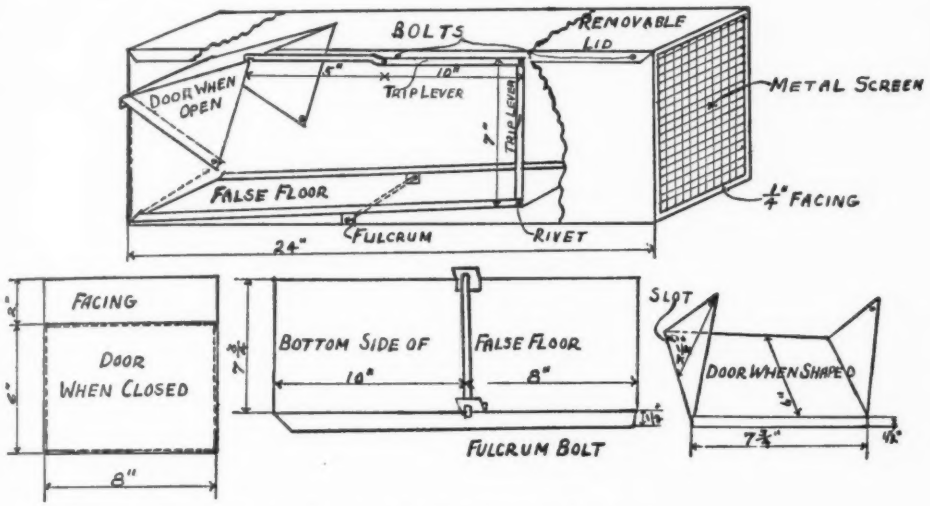

FIG. 1. Box trap for live hares and rodents.

The trap is made of galvanized sheet metal of medium weight. The two sides and bottom are shaped from one piece. The upper edges of the two sides have a ½-inch bend inward at right angles. This is for soldering two 1-inch strips across the top from side to side. The lid is removable and is held in place by small bolts. The ½-inch flange on the bottom of the door falls under the front end of the false floor, thus preventing the captured animal from nosing it open.

The door works on rivets placed loose enough to allow for free movement when released. The screen should preferably be ¼-inch mesh but never larger than ⅜-inch. The fulcrum bolt should be threaded on each end for nuts, and the supports through which the bolt runs soldered to the bottom of the false floor. The trip levers are made of strap iron 3/32 × ⅜ inch. The horizontal bar has a ½-inch vertical offset and a square notch cut or filed on the front end to catch into the door slot when the trap is set.

Any inside adjustments can be made after removing the top cover by unscrewing the four bolts with a screwdriver. The nuts to the bolts are soldered to the inside of the box directly over the hole. The cost of making these traps varies with the price of the materials and labor and also according to the quantity ordered. Most tinsmiths have machinery for cutting and shaping the metal.

The most successful and cheapest bait was well-cured leafy alfalfa hay. Baits such as carrots and parsnips would freeze hard in severe winter weather. The bait is placed inside the trap beyond the back end of the false door.

Traps should always be set in well-defined trails. It is not necessary to cover or to conceal them in any way. As many as eight traps can be carried by one man by use of a pole over the shoulder and wire hooks to catch onto the traps. Four traps can be easily carried by one man without the use of any ap-

paratus. When properly adjusted, the traps can be tripped by animals as small as mice. Such animals as ground squirrels, mice, chipmunks, toads, salamanders, weasels, red squirrels, skunks, and feral house cats have been taken alive in these traps in Minnesota. Skunks tend to mutilate the internal apparatus if held too long before being released. Even in weather as low as −35°F., hares did not die from exposure when held in the traps over night.—C. M. ALDOUS, *U. S. Fish and Wildlife Service, Ogden, Utah.*

EFFECT OF HIGH EXPLOSIVE BOMBING ON FISH

The Canadian and United States armies conducted a bombing test, February 23, 1945, at Wapawekka Lake, 180 miles north of Prince Albert, Saskatchewan, Canada, to determine the effect of high explosives on lake ice and the practicability of destroying airstrips on such ice. The lake is 12½ miles long by 5½ miles wide and shaped somewhat like an hour-glass, one end being considerably smaller than the other. The bombing was at the smaller end, in a water depth of about 30 feet; depths in the large end average about 100 feet. The ice at the point of bombing was 37 inches thick. The Canadian Department of Natural Resources gave permission to bomb the lake because the most important commercial fish there, the whitefish (*Coregonus couesi*) is badly infested with parasites and does not meet the required export tolerance.

The bombing was done from two B-17's flying at an altitude of 500 feet, using a 500-pound high explosive bomb with a "no delay" tail fuse and a 0.1 second nose fuse. Tests had shown that this bomb would penetrate approximately 3 feet of ice before exploding, and hence produce the greatest damage to the ice. The first plane dropped 3 bombs at 100 feet intervals, and the second the same number at 200 feet intervals. The two then simultaneously laid a pattern of 8 bombs each at 100 feet intervals, and in a close formation of about 100 feet. It was thought that the combined blasts of the two trains might cause heaving of the ice in the immediate area. Such was not the case, however; each bomb completely destroyed the ice in a crater about 50 feet in diameter but that between craters was undamaged.

Careful check at all bomb craters failed to show any fish killed by the explosives. A further check at the spring breakup by game officials of the Department of Natural Resources likewise failed to reveal any dead fish, but two dead whitefish were reported subsequently. At the time of the bombing, the whitefish would have been in the deep part of the lake and probably thus escaped destruction.—CARL R. EKLUND, *U. S. Fish and Wildlife Service, Portland, Oregon.*

POSSIBLE INCREASE IN POST-WAR HUNTING

Having previously worked with the Wisconsin Conservation Department and realizing that data on the possible increase to be expected in post-war hunting would be of value, the writer, by use of a questionaire, obtained answers on this topic from 322 servicemen. From July 1944 in the South Pacific, through July 1945 in the Central Pacific, servicemen from Michigan, Wisconsin, and Minnesota were asked to report on the subject and personal contact usually was secured to assure full understanding of the questions. One of every 50 among these men does not intend to return to his "home" state. Among so small a number, this figure may not be representative and might be entirely different for other states. The percentages are based upon the number who have hunted or plan to do so and do not indicate the amount of hunting.

Several articles have appeared in sporting and conservation magazines within the past year giving estimates as to the expected increase in hunting after the servicemen return; round figures in the millions were often mentioned. The writer does not have these articles available, but it is his impression that the estimates were much too high. Frequently the figures were based upon experience gained after World War I, but such guessing must be erroneous for several reasons. The previous war introduced high-powered rifles

to the general public much more than this war has or can. Also, after this war at least a quarter million men will not return, besides those severely injured; these numbers must be subtracted from any estimates.

The author realizes that 322 answers do not provide a good statistical average, but these data are better than guesswork. Of the answers, 20 were from states other than Michigan, Wisconsin and Minnesota but are included because the resulting figures were quite similar to those for the Lake States area. These latter were chosen because they have somewhat identical situations as to deer, waterfowl, and small game.

Deer are most important because they involve the serviceman's recently gained knowledge of high-powered rifles. Of those reporting, 58 per cent had previously hunted deer, and of the remainder, 26 per cent thought they would begin to hunt deer after they returned home. The other 16 per cent definitely stated they never would hunt deer; a few, incidentally, never wanted to see a rifle again. Questions also were asked to determine the percentage of city and non-deer country men among those contacted; of the prospective increase in deer hunters, 84 per cent are from cities or areas not considered good for deer hunting. Many of the men were young and had had little previous opportunity to follow this type of hunting because of the war emergency.

At one time or another, 87 per cent had hunted small game such as rabbits, squirrels or pheasants; among the others, 5 per cent indicated a desire to hunt small game when they returned home. The 8 per cent who do not expect to hunt even small game might be taken as a general figure for those young men who do not care for hunting as an outdoor sport.

The hunting of waterfowl seems to be more specialized; of servicemen from the Lake States, 40 per cent had not previously hunted ducks or other waterfowl. Of these, 16 per cent indicated that they would be interested in this sport after they returned home, and 24 per cent would rather not try for the fast-winged birds.

S/Sgt. Philip A. Moe of Chetek, Wisconsin, helped in securing some returns from men in the New Hebrides, Mrs. Walter E. Scott of Madison, Wisconsin, tabulated the answers.—WALTER E. SCOTT, *CIC Area Det. No. 57, APO 98, c/o Postmaster, San Francisco, California.*

NEWS NOTES

The Eleventh North American Wildlife Conference will be held in Hotel Pennsylvania, New York City, March 11 to 13, 1946. The 1945 Conference was postponed due to travel restrictions. Plans are being made for an even larger conference this year. Hundreds of wildlife technicians and scientists released from the Armed Forces will want to familiarize themselves with current programs. The sessions will consider reports on recent developments in field methods and future plans for conservation and restoration of natural resources throughout North America. Those planning to attend should make hotel reservations well in advance.

The general theme of the conference will be "The place of wildlife in a changing world." Three general sessions will be held, at which the subjects and chairman are to be as follows: "Public projects and wildlife welfare," Frederick C. Walcott, American Wildlife Institute; "Education in wildlife conservation," Fairfield Osborn, New York Zoological Society; "Modern demands on wildlife," I. T. Bode, Missouri Conservation Commission.

Persons interested in participating in the technical sessions supervised by the Wildlife Society should contact the chairman of the appropriate subject panel immediately. If that particular panel has been filled the application will be referred to other session chairmen or to the program committee.

The technical sessions and respective chairmen are as follows:

Agricultural lands and wildlife, Durward L. Allen, Rose Lake Wildlife Experiment Station, East Lansing, Mich.

Range and forest lands and wildlife, Fred P. Cronemiller, U. S. Forest Service, 630 Sansome St., San Francisco 11, Calif.

Fresh waters, marshes and wildlife, William Rowan, Alberta University, Edmonton, Alberta, Canada.

Marine habitats and wildlife, Daniel Merriman, Bingham Oceanographic Laboratory, Yale University, New Haven, Conn.

Advances in wildlife technique, Charles A. Dambach, Ohio Cooperative Research Unit, 96 W. California Ave., Columbus, Ohio.

Wildlife in business, Charles E. Jackson, National Fisheries Institute, 1835 K Street, N.W., Washington 6, D. C.

For some time there has been a feeling that forest wildlife management should be given more consideration by The Society of American Foresters. To provide for those working in this field, a Division of Forest-wildlife Management has been recently authorized within the Society. Officers serving until the next national meeting are N. W. Hosley, Chairman; P. D. Dalke, Vice-chairman; D. B. Cook, Secretary; and L. W. Swift and W. W. Chase additional members of the Executive Committee. During formation of the Division, it was emphasized that the group did not want to do anything to weaken The Wildlife Society. There was a general feeling however, that with The Wildlife Society now well established, emphasis on forest wildlife in the Society of American Foresters would be an aid. Committees are being formed and a division meeting is planned at the next annual meeting of the parent society.

The recent discovery of oil in tropical Florida raises a question as to the future of the Everglades as a haven for wildlife. The many egrets and herons now there are largely decended from 3,100 birds brought from Avery Island, Louisiana. The sanctuary developed by Edward A. McIlhenny at the latter island for various kinds of wildlife is close to a factory, railroad, and highway, yet the population of breeding herons and other species has been built to large numbers. Some nature lovers are alarmed over oil developmens in Florida as to the probable effect on the birds, but the experiences at Avery Island and elsewhere along the Gulf Coast indicate little cause for concern.

Mr. Edwin A. Mason, Arcadia Wildlife Sanctuary, Easthampton, R. D., Massachusetts, wishes to obtain a copy of the Seventh North American Wildlife Conference Transactions (1942).

EDITORIAL

War is wasteful of men, materials, and resources and cannot be justified on any basis. Yet World War II, besides achieving the primary objectives of the successful defenders, will bring some benefits to those interested in wildlife in North America. Heretofore there have been very few Americans with firsthand knowledge of the wildlife and of wildlife management in other lands. Now there is a vast number of young citizens who know much of these matters. Any sizeable gathering of returned veterans will include individuals whose experiences touched variously the principal countries of the world. A college class now may contain students knowing details about the climate, plant cover, wildlife, and local economy of England and Scotland, France, Germany, Italy, the Near East, North or West Africa, parts of South America, Australia, India, Burma, China, and the Pacific Islands large and small. Many of them hunted at home before "going abroad" and they and their companions saw various exotic environments; some of necessity hunted and lived on game in far places. These young men have a perspective touching conservation unlike any previously known. They will contribute to "barbershop forums" where so many matters relating to wildlife are discussed, and whence emerge opinions expressed to legislators and wildlife executives. We may expect much from the wider experiences and perspectives of the returned members of our armed forces.—TRACY I. STORER.

REVIEW

Cooking wild game. Meat from forest, field and stream and how to prepare it for the table—432 recipes. By Frank G. Ashbrook and Edna N. Sater. New York, Orange Judd Publishing Co. xix+358 pp., illus. $4.00. 1945.

Is it the final purpose of wildlife management to afford a wider chance for aesthetic appreciation of animals, a greater opportunity for displaying skill with gun and rod, or more and better gastronomic enjoyment? To the last of these aims the present volume is dedicated; appropriately it bears a quotation from Brilliat-Savarin and a foreword by J. N. Darling, both appreciative devotees of the art of cooking game.

The opening chapter indicates some "uses and abuses of game" that led to present day circumstances of the supply, and is followed by brief comments on the food value of game —as if such arguments were needed. The real meat of the book starts at page 23, with the "preparation of game for cooking"; this deals with the care of game carcasses in the field, including methods of dressing and butchering. It could well have included some informative illustrations as to the means of skinning out deer and elk, and suggestions about caring for game which must be transported over long distances in hot or warm weather. Methods are given for both upland birds and waterfowl, but none for fish. There are paragraphs on cooling, handling, and storage, including several on the wrapping and other essentials for freezing game. Directions are provided for the preservation of meats by brining, smoking, and canning, and for the various methods of cooking game meats.

Chapters V and XII are replete with directions wherein each hunter and each recipient of a hunter's bounty may find cooking methods suited to his liking or fancy, or to the resources of his kitchen in respect to the needed accessories. At random, various recipes deal with "jugged wild rabbit," "beaver pot roast," "smothered muskrat," "squirrel pie," "deer tongue," "fried pheasant," "wild duck with dressing," "broiled whale steak," "shark chowder," "carp flakes," "sea mussels" [beware in summer along the Pacific coast!], "frog legs," and domestic "fried rabbit supreme." These have been culled from a variety of sources indicated in the bibliography of 73 titles.

There are included directions for overcoming fishy flavor in ducks, for removing scent glands in small game, for marinades to tenderize game and enhance the flavor, and a variety of other reliable suggestions for using this original source supply of human food.

Here is a useful volume wherein the student of wildlife and wild populations who takes a practical interest in the harvest of his crop may follow through and test, according to appropriate "formulas," the value of that crop in ultimate consumption.—Tracy I. Storer.